OPHIR

Laser Measurement Group

NOVA

NOVA

LASER POWER/ENERGY MONITOR

USER MANUAL

OPHIR OPTRONICS

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Chapter 1 Introduction: How to Use This Manual

The Ophir Nova is a microprocessor-based Laser Power/Energy Meter providing a broad range of measurements, displays, and data handling options. It operates with thermopile, pyroelectric and photodiode heads, and uses smart connector technology. Just connecting the head configures and calibrates the instrument.

This manual tells you what you need to know to make full use of the Nova for all your laser measurement needs. It includes a "Quick Reference", (Chapter 2) to allow you to perform basic measurements immediately, without reading the whole manual.

The main measurement sections, Chapters 4, 5 and 6 include a general description and a section detailing operating options.

Chapter 2 Quick Reference

2.1 Getting Started

The Nova is equipped with "soft keys." That is, the functions of the keys change as indicated by the legend above each key. (See Figure 2).
When the Nova is first switched on, the first screen usually has a digital display with a bargraph at the bottom. In order to access the soft keys, press the menu button, located in the second row on the right of the panel. Pressing the menu button again will access more functions. Pressing it yet again will bring it back in a cyclical manner to the original bargraph screen.

To connect head to the Nova Display

Insert the D type connector of the measuring head cable into the socket marked "Head Input" on the rear panel of the Nova display. (See Figure 1)

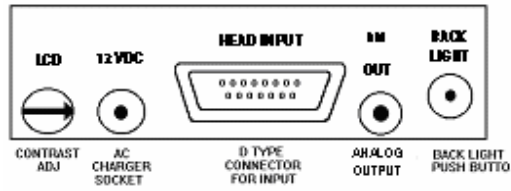


Figure 1
Nova Rear Panel View

To switch the Nova on:

1. Push up the slide switch on the left side of the Nova display. (See Figure 2).

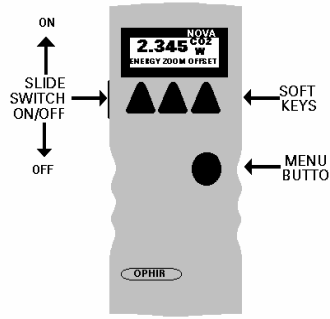


Figure 2.
Nova Top View

The unit will switch on, and the display will appear.

Note:

The head must be plugged in before the unit is switched on.

To switch the Nova off:

1. Return the slide switch to its original position.
2. If you wish to save the current Nova configuration, use the "configure" function before switching off. See below, Section 2.2.2 or refer to the main body of the manual for details.

To set line frequency:

1. Disconnect the head and switch off then on again. "Head Disconnected" will appear.
2. Press "select" until "line freq" is highlighted.
3. Press "go" then change to correct frequency.
4. Press "exit" and change will be saved.

To zero instrument:

1. Disconnect head, turn off then on again. "Head Disconnected" will be displayed.
2. Press "select" until "zero" is highlighted.
3. Press "go".
4. Make sure instrument is not in an electrically noisy environment and is undisturbed. Press "go" and wait for message, "zeroing completed". Press "exit".
5. For thermal heads, zeroing with the head may also be necessary. See section 3.5.2.

2.2 Thermal Heads

2.2.1 Use of Nova with thermal type heads

To set type of laser being used:

1. While the Nova is off, plug in the head then switch it on again.
2. From bargraph measurement screen, press the menu button twice and press "laser" until the correct laser type is displayed.
3. Return to bargraph screen by pressing the menu button again.

To choose manual or automatic ranging in power measurement:

1. From the bargraph measurement screen, press the menu button once, then press "range" or simply press the right most soft key.
2. Select the appropriate manual range or autorange.
3. Press "exit" and then press the menu button twice to return to the bargraph measurement screen.

To choose power or energy measurement:

1. To go from the bargraph power measurement screen to the energy measurement screen, press the menu button then press "energy".
2. Alternatively, you can press the leftmost soft key directly from the bargraph screen to go to energy measurement.
3. To go from the energy measurement screen to power measurement press the "power" soft key.

2.2.2 Setting and Saving Startup Configuration

1. From the power measurement mode, press the menu button located on the right side until "more" appears. Press "more".
2. Press "select" until "configure" is highlighted. Press "go".
3. Press "value" to choose "power" or "energy" for the desired startup screen.
4. Press "select" until the laser type is high-lighted. Now press "value" to select the laser type you wish to be the default.
5. Press "select" and "value" to choose the manual power range you wish to be the default or choose autorange.
6. Now press "select" and "value" again to choose the default energy range.
7. Press "exit" then "all" to save all present settings.

Further details on configuration in section 4.3.

2.2.3 Power or Single Shot Energy Measurement

Warning:

Do not exceed maximum head limits for power, energy, power density and energy density as listed in tables 6 and 7 in section 9.2. Otherwise, there is a risk of damaging the absorber.

To use the Nova to measure Laser power:

1. Verify that the display shows power units in W, mW etc.
2. If the display shows energy units of J, mJ etc. then press "power" to switch to the power measurement mode.

To expand the bargraph scale ±10% about the present reading:

1. From the bargraph power measurement screen press the center button.
2. Press the center "zoom" button again to return to full scale.

To subtract background and set current reading to zero:

1. From the bargraph power measurement screen press the menu button twice then press "offset". Press the menu button once to return to the bargraph screen.
2. Press "offset" again to cancel. See Section 4.4.2.2. for full details.

To use the Nova to fine-tune Laser power:

1. From the bargraph power measurement screen press the menu button twice then press "more".
2. Press "select" until "tune" is highlighted. Press "go".
3. Set the percentage range of the power scale to be displayed by repeatedly pressing the left key.
4. Set the horizontal sweep time using the middle soft key See Section 4.4.2.3. for full details.

To use the Nova to measure Laser energy:

1. In measurement mode, verify that the units are J, mJ etc. If not, press the menu key until "energy" appears. Press that key to switch to energy measurement mode. Alternately, press the left soft key directly.

2. The energy mode is manual ranging. Press "range" then the "up" "down" soft keys until the proper range is highlighted then press "exit". The correct range is the lowest one that is larger than the pulse energy measured.
3. When the Nova screen flashes "ready," on and off, fire the laser. See Section 4.5 for full details.

To save configuration:

1. To save configuration, follow directions in Section 2.2.2 above.

2.3 Photodiode Heads

2.3.1 Use of Nova with photodiode type heads

To set type of laser being used:

1. From bargraph measurement screen, press the menu button twice and press "laser" until the correct laser wavelength is displayed.
2. Return to bargraph screen by pressing the menu button again.

To choose manual or automatic ranging or dBm in power measurement:

1. From the bargraph measurement screen, press the menu button once.
2. Press "range" and then select the appropriate manual range, autorange or dBm (logarithmic scale).
3. Press "exit" and then press the menu button twice to return to the bargraph measurement creen. Alternately, range is accessed directly by pressing the right most soft key from the bargraph screen.

2.3.2 Selecting Chosen Wavelength

1. From the power measurement mode, press the menu button until "more" appears. Press "more".
2. Press "select" until "wavelength" is highlighted. Press "go".
3. Press "change" then "up" and "down" to select the first wavelength. Repeat steps 2 and 3 for other wavelengths desired. Up to 6 wavelengths may be selected.

2.3.3 Setting Startup Configuration

1. From the power measurement mode, press the menu button until "more" appears. Press "more".
2. Press "select" until "configure" is highlighted. Press "go".
3. Now press "value" to select filter in or out to be the default.
4. Press "select" and "value" to choose the manual power range you wish to be the default or choose autorange.
5. Now press "select" and "value" again to choose the startup laser wavelength. For further details on configuration See Section 5.3.

2.3.4 Power Measurement

Warning:

Do not exceed maximum head limits for power, energy, power density and energy density as listed in tables 6 and 7 section 9.2 Head Specifications. Otherwise, there is a risk of damaging the absorber.

To expand the bargraph scale 10% about the present reading:

1. From the bargraph power measurement screen press the menu button. Then press "zoom". Now press the menu button twice again.

Alternatively press the center button from the bargraph screen without the menu button.
2. Press "zoom" again to return to full scale.

To offset current reading and set to zero:

1. From the bargraph power measurement screen press the menu button, press "offset" then press menu twice to return to the bargraph screen. Alternatively press the left upper button from the bargraph screen.
2. Press "offset" again to cancel. See Section 5.4.5. for more details.

To use the Nova to fine-tune laser power:

1. From the bargraph power measurement screen press the menu button twice, then press "more".
2. Press "select" until "tune" is highlighted. Press "go".
3. With the left soft key set the percentage range of the power scale to be displayed .
4. Set the horizontal sweep time using the middle soft key. See Section 4.4.2.3. for full details.

2.4 Pyroelectric and Photodiode Energy Heads

2.4.1 Selecting Chosen Wavelength

1. While the instrument is switched off, plug in the head, then switch on.
2. From the bargraph screen which appears, press the menu button until "more" appears. Press "more".
3. Press "select" until "wavelength" is highlighted. Press "go".
4. Press "select" then "change" then "up" and "down" to change the first wavelength. Now press "done". Repeat steps 2 and 3 for other wavelengths desired up to 6.
5. Save configuration as described in Section 2.4.4.

2.4.2 To set type of laser being used

1. From bargraph measurement screen, press the menu button twice and press "laser" until the correct laser type or wavelength is displayed.
2. Return to bargraph screen by pressing the menu button again.

2.4.3 To set Laser Pulse and Average

1. From the bargraph measurement screen press the menu button twice then press "setup".
2. Press "value" to choose the short pulse or long pulse setting depending whether the pulses of your laser are less than or greater than the short setting.
3. Press "select" then "value" to choose the time period over which you wish to average energy readings. Press "exit".
4. Save configuration as described in section 2.4.4.

Warning:

Incorrect readings will result if pulse length is not set up correctly.

Note:

Some heads have only one time setting for all pulse lengths. In that case "N.A." appears.

2.4.4 Setting Startup Configuration

1. From the bargraph energy measurement mode, press the menu button until "more" appears. Press "more".
2. Press "select" until "config" is highlighted. Press "go".
3. Press "value" to choose "power" or "energy" for the desired startup screen.
4. Press "select" until the laser wavelength is highlighted. Now press "value" to select the laser type you wish to be the default.

5. Press "select" and "value" to choose the pulse length you wish to be the default.
6. Now press "select" and "value" again to choose the default energy range.
7. Press "exit" then "all" to save. For further details on configuration See Sections 6.2 and 6.3

2.4.5 Setting up PE-DIF diffuser heads to diffuser IN or OUT setting

1. Press the menu button twice and press “setup”.
2. Press “select” until the diffuser setting is highlighted and select “IN” or “OUT” as desired. Make sure the diffuser is physically installed or not installed on the head. Press exit.
3. Press the menu button twice and press “laser” until the correct wavelength is selected. Note that only wavelengths compatible with the diffuser setting are visible. (All wavelengths for diffuser IN have a D suffix, e.g. 106D = 1.06μm, diffuser in).
4. If you wish to save these settings as the defaults, from the main display, press the menu button twice then press “more”. Select “config” and press “go”. Press “exit” and “all” to save all present settings including diffuser IN or OUT.

2.4.6 Energy or Average Power Measurement

Warning:

Do not exceed maximum head limits for power, energy, power density and energy density as listed in tables 6 and 7 section 9.2 Head Specifications. Otherwise, there is a risk of damaging the absorber.

With the pyroelectric head, you have been supplied a test slide with the same coating as on your pyroelectric detector.

You can also obtain this slide from your dealer. You should use this slide to test the damage threshold with your laser pulses. If the slide is damaged, then either enlarge your beam or lower the laser energy until damage is no longer seen.

2.4.6.1 To choose Energy or Average

1. To go from the bargraph energy measurement screen to power measurement, press the menu button then press "power". Alternately, you can press the leftmost soft key directly from the bargraph screen to go to power measurement.
2. To go from the bargraph power measurement screen to energy measurement, press the menu button then press "energy". Alternately, you can press the leftmost soft key directly from the bargraph screen to go to energy measurement.

2.4.6.2 To use the Nova to measure Laser Energy and Frequency

1. In measurement mode, verify that the units are mJ, µJ etc. If not, press the left most soft key.
2. Press the menu button once then press "range" then the "up" "down" soft keys until the proper range is highlighted. The correct range is the lowest one that is larger than the pulse energy measured.
3. Press "exit" then press the menu button twice to return to the bargraph measurement screen. If you wish to have the frequency displayed, press the menu button only once.

2.4.6.3 To use the Nova to measure Average Power

1. Verify that the display shows power units in W, mW etc.
2. If the display shows energy units of J, mJ etc. then press "power" to switch to the power measurement mode.

2.4.6.4 To expand the bargraph scale fivefold about the present reading

1. From the bargraph energy or power measurement screen press the menu button then press "zoom", then press the menu button twice, or just press the center button from the bargraph screen.
2. Press "zoom" again to return to full scale.

2.4.6.5 To measure Total Energy Exposure

1. Press the menu button until "more" appears. Press "more".
2. Press "select" until "exposure" is highlighted. Press "go".
3. Select parameters then press "go". Press go again. The Nova will start summing laser energy exposure and the legend will change to "stop".
4. When you wish to stop measuring, press "stop". If you wish to reset reading to zero before another reading, press "reset".
5. To return to the bargraph screen, press "exit".

Chapter 3 The Nova Display Unit

3.1 General Description

The model Nova laser power/energy meter represents a new level of sophistication, sensitivity, compactness and accuracy, coupled with ease of operation. It can operate with thermal, pyroelectric and photodiode heads. It has smart connector technology. Simply plugging in the head configures and calibrates the Nova to operate with that head.
The Nova can graph power or energy vs. time. It displays power measurements in both digital and analog form at the same time. It will also autorange, so you do not have to set scales; or it can manual range if you wish. It will remember what mode you were using before you turned it off and will return to that mode when turned on. You can zoom in on the present reading, or subtract background. Although the calibration information is stored in the smart connector, you can recalibrate from the screen and store the new calibration in the head. You can also zero the Nova at the touch of a button.

The main instructions are clearly shown on the screen so you should not have to refer to this manual very often. Above all, the Nova has advanced circuitry and digital signal processing for excellent sensitivity, signal to noise ratio, accuracy, and response time. It also has special circuitry to reject electromagnetic interference.

3.2 Smart Connectors and Multihead Operation

The Nova display, although very compact, is versatile and can operate with either thermal, pyroelectric or photodiode type laser measuring heads. The head configuration and calibration information is stored in an EEROM in the head connector plug. This means that when the head is plugged in, the Nova automatically identifies the head type, calibration and configuration. The user does not have to adjust anything.

Note:

The Nova automatically loads the head information when first turned on, so when changing heads, the display should be turned off, the new head plugged in and then be turned on again.

When no head is plugged in and the Nova is turned on, the display indicates "Head Disconnected" and gives the user the opportunity to change the power line frequency or rezero the instrument. See section 3.4.

3.3 Soft Keys and Menu Button

3.3.1 Menu Button

The Nova is equipped with "soft keys". That is, the functions of the keys change as indicated by the legend above each key. (See Figure 3).
When the Nova is first switched on, the first screen usually has a digital display with a bargraph along the bottom. In order to access the soft keys, press the menu button, located in the second row on the right of the panel. Pressing the menu button again will access more functions. Pressing it yet again will bring it back in a cyclical manner to the original bargraph screen.

Note:

The first set of menu choices can be accessed without pressing "menu". Simply pressing the appropriate key from the bargraph screen will operate that key even though the label is not visible. So if you remember the position of the key you can take a shortcut. If the soft key is an alternating "toggle" type, the label will be visible while the key is being pressed.

3.3.2 Soft Keys

The soft keys accessed by the menu button have functions defined by the legend above the key. The legend usually indicates what will happen when pressing the key. For example, if "energy" appears above a key, pressing that key will change the Nova into energy mode. Some functions operate when the key is pressed and are canceled when the key is pressed again. The keys show reverse highlighting when operational. Pressing the same key again cancels the operation and the highlighting.

Nova Top View

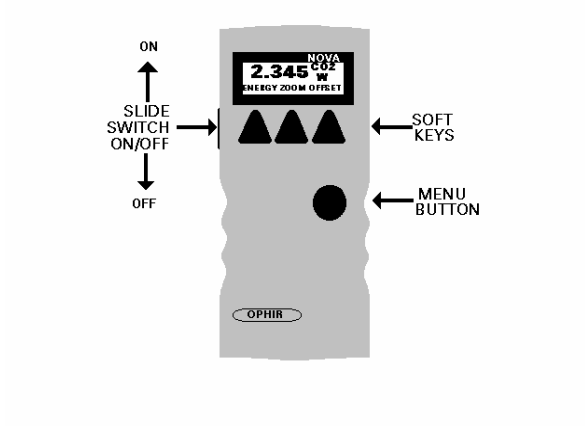


Figure 3.
Nova Rear Panel View

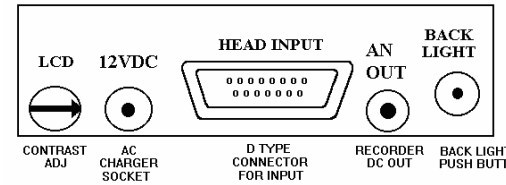


Figure 4

3.4 Power Up and Shut Down

To turn the Nova on:

1. Push up the slide switch on the left side of the Nova display. (See Figure 4)
2. The unit will switch on, and the display will appear. If no head is connected, a display showing "Head Disconnected" will appear. If a head is connected, the appropriate default measurement screen will appear.

To switch the Nova off:

1. Return the Switch to its original position.
2. If you wish to save the current Nova configuration, use the "configure" function before switching off. For measurements of the same type, the Nova does not need to be set up each time. *See the appropriate section in the chapter dealing with the head type you intend to use.*

3.5 Nova Functions which are independent of Head Type

When no head is connected to the Nova and it is turned on, the message "Head Disconnected" appears. In this mode, the user can adjust either the power line frequency so the instrument can be adjusted for minimum interference at the power line frequency, or the user can zero the instrument to eliminate any offsets.

3.5.1 Line Frequency

The Nova is factory set for 50 Hz. If your country uses 60 Hz you must reset the line frequency.

To reset the line frequency:

1. Turn on the Nova while the head is disconnected.
2. Press "select" until "line frequency" is highlighted.
3. Press "go" then change to select the correct line frequency.
4. Press "exit" to save the new value and exit.

3.5.2 Zero Adjustments

In the Nova, all adjustments, including zeroing internal circuits, are done from the software. This ensures simple and accurate realignment. It is recommended to rezero the Nova every 2 months for best performance. The simple zeroing procedure follows.

1. If a head is connected, disconnect the head, turn off the instrument then back on again so the Nova can identify that no head is connected. "Head Disconnected" will be displayed.
2. Turn on the Nova, and let it run for at least 30 seconds before performing zero adjustment.
3. Press "go".
4. Make sure the instrument is not in an electrically noisy environment and is undisturbed. Press "go" and wait for message, "zeroing completed". Now press "exit" and "saved" will be exhibited, indicating that the zero configuration has been saved.

Note for Thermal Heads only:

For best results with thermal heads, it may be necessary to do the procedure once with the head disconnected then afterwards again with the head connected.

After completing steps 1 - 5 above, Connect the head and make sure it is at room temperature and well shielded from any stray thermal power. It may be best advised to lay the head with the absorber face down on the table.

5. Switch the instrument off then on again with the head connected.
6. Press the menu button twice then "more". Press "select" until "zero" is highlighted.
7. Now repeat steps 4 and 5 above.

3.5.3 Baud Rate

If you are using the Nova for communication with PC, the baud rate can be set by selecting "baud rate" pressing "go" and selecting the appropriate rate. For most purposes, the default of 9600 Baud will suffice.

3.6 Backlight

The backlight illuminates the display from the rear and is operated by a push button on the back panel (See Figure 3). Since the backlight consumes considerable power, it is operable only when the charger is plugged in.

The electroluminescent backlight does have a finite lifetime of about 10,000 hours. Therefore, it is recommended only to use it when necessary. To turn on the backlight, push the push button while the charger is connected. To turn off the backlight, push the button again.

3.7 Kickstand

The Nova is equipped with a kickstand on the underside of the case so the display can be tilted for easy viewing. The kickstand folds away in a recessed slot when not in use. When the Nova is folded flat, it is only 203 x 95 x 35 mm, the most compact unit of this type on the market.

3.8 Charging

The Nova is operated by a rechargeable battery. To charge the battery, plug the charger into the jack labeled "12VDC" on the back panel, (Figure 3). Note the polarity of the charger. The Nova will charge the batteries at about the same rate whether it is on or off and whether the backlight is on or off – it fully charges in about 14 hours. However, it will charge more slowly while operating a pyroelectric type head. It is not recommended to leave the charger plugged in for much longer than 14 hours, in order to preserve the battery lifetime. The unit will operate about 18 hours from one battery charge. When the battery is low, "BAT" flashes on and off indicating that the battery needs recharging. However, even with "BAT" displayed, the unit will operate properly for about one hour before its accuracy will be impaired.

3.9 Chart Recording

The instrument provides an analog voltage output via a 2.5mm pin jack labeled "AN OUT" on the rear panel (See figure 3).
This is useful for driving chart recorders and other analog devices.
The voltage is proportional to the reading on the display and scaled such that full scale equals 1.00 volts.
The output can drive up to 2mA into an external device.

3.10 Beam Splitter Function

If you have a measurement setup with a beam splitter or attenuator and wish to display the laser power or energy before the splitter or attenuator and not the actual value impinging on the measurement head the beam splitter function allows you to do this. For example, if you are splitting off 4.5% of a laser beam into the meter and you wish to display the full beam, do as follows:

1. Press the menu button twice and press “more” then select “atten”. Press “go”.
2. Press “select” so the screen says “attenuation screen – on”. Press “exit”.
3. Press “set %”. Now alternately press “select” and “change” to set the value of the percent split off to 4.5%. Press “exit” and the value will be saved.
4. When you turn on the Nova now with a measuring head, the display will come up in the attenuation screen and the value displayed will be 1/(attenuation fraction) instead of the power or energy actually on the screen. For instance in the present example, if the laser power on the head is 5.5 Watts, 5.5/0.045 = 122.22 Watts will be displayed. If the menu button is pressed again, you will be in the normal measurement screen where the actual value measured is displayed.

5. If you want to have the Nova come up in the normal measurement screen, reverse the process in steps 1 and 2.

Note 1:

The factory default for this screen is 100.00% and in that case, the regular screen comes up on startup and not the attenuator screen.

Note 2:

The attenuator screen only affects the value displayed on that screen and nothing else. The power and energy scales remain the same, the damage thresholds remain the same etc. The attenuator screen is only an extra screen to show a different calculated number introduced by the user.

Chapter 4 Operation with Thermopile Absorber Heads

Warning:

Before using the head for power or energy measurement, check that your laser power, energy and energy density do not exceed the head ratings. See tables in section 9.2 Head Specifications.

If the head is a water-cooled type, ensure that the cooling water is flowing at an adequate rate; see table below. Also, note that the reflectance from the absorber could be as much as 10% and with CO2 lasers, the reflected beam can be quite specular, so it is advisable to provide a beam stop for the reflected beam with the highest power lasers.

HEAD TYPE	LITERS PER MIN	MIN PRESSURE BAR	US GALLONS PER MINUTE
8000W	7	1.5	2
5000W	4.5	0.8	1.2
L1500W	2.5	0.5	0.7
1000W	1.7	0.4	0.5
300W	1.0	0.3	0.25

Table 1.
Minimum Flow Rates For Water-cooled Heads

4.1 Thermopile Absorber Heads

When a radiant heat source, such as a laser, is directed at the absorber head aperture, a temperature gradient is created across the thermopile of the enclosed detector disc. This generates a voltage proportional to the incident power.

The display unit amplifies this signal and indicates the power level received by the head. At the same time, signal processing software causes the display unit to respond faster than the thermal rise time of the detector disc, thus reducing the response time of the Nova. Energy of a single pulse is measured on the Nova by digitally integrating the pulse power over time.

4.2 Selecting Settings from the Nova Screen

The Nova can be set to various chosen settings while operating. In addition, it can be set so that it will be in the desired configuration when turned on the next time.

4.2.1 To Set Type of Laser being Used:

Thermopile heads have somewhat different absorption at different wavelengths. In order to compensate for this, each head has been calibrated by laser at several wavelengths.

When you choose the correct laser wavelength, the correction factor for that wavelength is automatically introduced.

Note:

The laser wavelength correction in use is displayed in the upper right corner of the display.

In order to choose the laser type, do the following:

1. From the bargraph power measurement screen, press the menu button twice and press "laser" until the correct laser type or wavelength is displayed.
2. Return to the bargraph screen by pressing the menu button again.

4.2.2 To choose Manual or Automatic Ranging in Power Measurement:

Autorange - The Nova allows you to choose autorange or manual ranging. In autorange mode, you do not have to change scales. When the reading of the meter or bar is more than 100% of full scale, the range goes to the next higher one. The ranges are arranged in factors of 1, 10, 100, etc. When the reading falls below 90% of full scale, the range changes to one range lower. This change only occurs after a few seconds delay. This provides overlap (hysteresis) to keep the Nova from flipping back and forth when reading close to the end of the scale.

Manual Range - There are certain disadvantages to autorange since it changes scale even if you don't want it to do so. If you want to measure the same range all the time, it is better to use manual range. To select manual range press the menu button twice until "range" appears. Press "range" then press "up" or "down" to select the desired manual range. The correct range to select is the lowest one which is larger than the largest expected measurement.
Now press exit to return to the measurement screen. If you wish the Nova to be in manual mode when switched on, save this configuration before switching off. See Section 4.3.

To choose auto or manual range, follow these steps:

1. From the bargraph measurement screen, press the menu button once.
2. Press "range" and then select the appropriate manual range or autorange by pressing the "up" or "down" buttons.
3. Alternately, you may directly access range from the bargraph screen by pressing the right most soft key.
4. Press "exit" and then press the menu button again to return to the bargraph measurement screen.

4.2.3 To choose Power or Energy Measurement

The Nova thermopile heads can measure both power and single shot energy. See sections 4.4. and 4.5. for details. To change from power to energy measurement or vice versa do the following:

1. To go from the bargraph power measurement screen power to energy measurement, press the menu button then press "energy". Alternately, you can press the left most soft key directly from the bargraph screen to go to energy measurement.
2. To go from the energy measurement screen to power measurement press the "power" soft key.

4.3 Startup and Configuration of Defaults

If you are planning to do measurements of the same type most of the time, you can set up the Nova so that it automatically starts up in the measurement mode desired. Since these settings are saved in the head "smart connector", you can save different settings for different heads.

To set the Nova to start up in power or energy measuring mode and to save the chosen configuration:

1. From the power measurement bargraph screen, press the menu button located on the right side until "more" appears. Press "more".
2. Press "select" until "configure" is highlighted. Press "go".
3. Press "value" to choose "power" or "energy" for the desired startup screen. The Nova will now start up in power or energy measurement mode, respectively, when switched on.
4. Press "select" until the laser type is highlighted. Now press "value" to select the laser type you want to be the default. The Nova will now be correctly calibrated for the absorption of the detector at the wavelength of the laser type selected.

5. Press "select" and "value" to choose the manual power range you wish to be the default or autorange. The Nova will now be in the mode selected when switched on with the head in question.
6. Now press "select" and "value" again to choose the default energy range.
7. Now press "exit" when all selections have been made.
8. Now press "all " if you wish to save all functions presently selected or "previous screen" to change the defaults of the previous screen only.

4.4 Power Measurement

The next section describes the procedure for basic power measurement as well as more advanced features with thermal measuring heads.

4.4.1 Power Measurement, Basic Operation

1. Switch the Nova on by means of the switch on the left side. (See Figure 4). The Nova will enter the mode of operation last saved with the "configure" operation. For basic operation, you need only set up the parameters for the type of measurement you wish (Section 4.3 describes the procedure to store your configuration.), and the Nova will be ready to perform that type of measurement each time it is switched on. The normal default mode is the bargraph autoranging power measurement screen.
2. If the Nova is in "energy" mode, pressing the "power" soft key will cause it to enter the power measurement mode.
3. Center the laser beam carefully on the absorber surface and read the power.

4.4.2 Advanced Power Measurement Features

The following section describes additional Nova functions in power mode in addition to the basic power measurement mode described above.

4.4.2.1 Zoom

The Zoom function causes the scale to expand the present scale fivefold. Thus, if the full scale of the bargraph is 20 watts, and your reading is 15 watts, pressing "zoom" will make the bargraph scale range between approximately 13 and 17 watts. Variations in power are more easily seen in this mode.

To access the zoom function, press the menu button until "zoom" appears. Then press "zoom". When it is highlighted it is engaged. Now press the menu button twice to return to the bargraph power display. Note that the fiducial marks of the bargraph are further apart, indicating that zoom is engaged. You may also directly engage the zoom function from the bargraph screen by pressing the middle button. Note that while the button is pressed, the soft key legend appears. Pressing "zoom" again will cancel the function.

4.4.2.2 Offset

The offset function subtracts background from the signal. If the ambient environment has a thermal background, so that the Nova shows a nonzero power reading even when there is no laser, you can subtract the background using the zero function. For example, the Nova display reads 0.1 Watts when the laser is blocked, and 20.5 Watts with laser power applied. In this case, the true power is 20.5 - 0.1 = 20.4 Watts. To subtract the background, press the menu button until "offset" appears and press "offset" while the laser is blocked.

Now press the menu key again to return to the bargraph screen. The Nova will now read zero, and the 0.1 Watt background will be subtracted from all subsequent readings. The laser power reading will thus be 20.4 Watts.

When "offset" is engaged, the legend is highlighted. To cancel, press "offset" again. If the "offset" is engaged, and you wish to subtract out a new value of the background, press "offset" twice. The first press will cancel the old value, and the second will activate a new value. If you suspect that the Nova has a permanent zero offset, then disconnect the head while it is in the power measurement mode. If the Nova still shows a similar offset even when the head is not connected, the instrument internal zero should be reset. See Section 3.5.2.

4.4.2.3 Tune (See Figure 5)

The Tune function, an exclusive Ophir feature, makes adjusting your laser to its maximum power easier than ever before.
Unlike a bargraph or mechanical meter, this display shows graphically what came before as well as the current reading and the trend. This allows you to determine if you have reached maximum power.

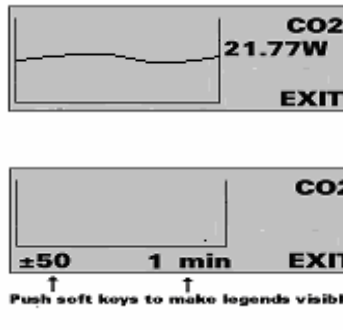


Figure 5
Tune Screen

The screen is completely autoranging. Therefore, as soon as the cursor goes over the top or under the bottom edge of the display, it rescales to put the cursor back to the middle of the screen. This allows you to devote all your attention to tuning the laser, without having to worry about the Nova settings.

To use the Nova to fine tune laser power:

1. From the bargraph power measurement screen press the menu button twice then press "more".
2. Press "select" until "tune" is highlighted. Press "go".
3. Press the menu button once to make legends visible. Press again to reset and return to measurement screen.
4. Set the power expansion scale to ±50% ,±120% or ±20% as desired, using the left soft key.. The default value is 50%. If the laser power will change a lot, use a large value; if a little, use a small value.
5. Set the horizontal sweep time to the rate desired, using the middle soft key. The default value is 1 minute. Both the expansion and time settings are saved for future use when using the configure function. See section 4.3.
6. Measure the power of the laser and adjust the laser until you determine that the power has reached a maximum.

4.4.2.4 Powerlog (See figure 6)

The Nova in Powerlog mode has the option of graphing the laser power against time, or successive energy points as long as the Nova has not been turned off. While measurements are being taken, the Nova will record data until the screen is full or until the center "reset" or "exit" button is pressed. With the optional Ophir RS232 adapter, this data can be read out to PC in real time or in later after storage. Contact your Ophir agent for details.

To use the Nova to graph power vs. time:

1. From the bargraph power measurement screen, press the menu button until "range" is shown. Press "range". Select the appropriate manual range and exit. (The Nova must be in manual range to use the powerlog function.)
2. Press the menu button until "more" is shown. Now press "more" and "select" until "power log" is highlighted. Press "go".
3. Set the maximum power on the scale by pressing "value" until the desired value is highlighted.

4. Now press select until the minimum setting is highlighted. Press "select" until minimum value on graph is chosen.
5. Press "select" again and then use "value" to choose the desired horizontal time scale. Press "go". The measurement will begin immediately.
6. When the screen is full, the measurement will stop and the graph will be held until the center reset button is pressed again.
7. The center button is the "reset" button. Press this button to reset the screen and begin a new measurement. Press the menu button once to make the legends visible, and press the menu button again to make the legends disappear.

Warning:

Pressing "reset" will erase all previously stored data and start recording new data.

8. The left button is the "setup" button. Press this button to go to the setup screen and readjust measurement scales. The legends are visible when the buttons are pressed or when pressing the menu button.

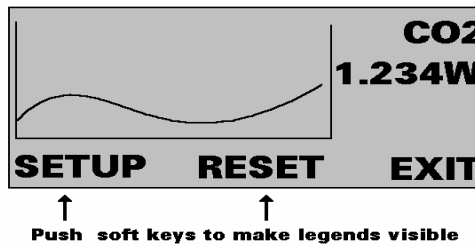


Figure 6.
Laser Power vs Time Graph

4.4.2.5 Average

When a laser output is fluctuating or unstable, it is useful to measure the average power over a certain period. The Nova gives you this exclusive feature, allowing averaging over periods varying from 1/3 s to 1 hour.

The Nova allows two modes of averaging: "continuous" or "periodic" mode. The periodic mode is meant for lasers which have rapid power fluctuations. In this case, choose an averaging period from .33 to 30s. The Nova averages over each period and displays the result at the end of each period until the next average arrives. The continuous mode is meant for lasers having slow variations in output over a relatively longer period. In the continuous mode, the Nova displays a running average which is continuously updated as time progresses. At the end of the period, the measurement stops and the last value is displayed until the instrument is reset. In continuous mode, the measurement period is from 10s to 1hour.

To use the Nova to display average:

1. The average mode works only with manual range. From the bargraph power screen, press the menu button and press "range". Select a manual range and press "exit".
2. Press the menu button again then press "more". Press "select" until "average" is displayed. Press "go".
3. Now press "value" to select periodic or continuous mode as described above. Press "select" and "value" to choose the time period desired. Press "go".
4. The average will be displayed. If you wish to stop temporarily, press "stop". After stopping, press "go" to continue. If you wish to start over, press "reset", the readings will be set to zero and then press "start".
5. If there is a zero offset (see section 4.4.2.2.) then you may subtract the offset by pressing “offset”.

4.4.2.6 Attenuation Screen

The Nova allows you to scale your measurement so as to display the original power reading of a laser beam which has been split or attenuated by a beam splitter or attenuator.

For instance, if your original laser power is 100 Watts, and you have split off 5% of the power, i.e. 5 Watts and are measuring only the 5 Watts, you can display the nonsplit value with the attenuation screen. To do so, do the following:

1. From the main screen press the menu button twice and press “more”. Select “atten” and press “go”.
2. Select “attenuation screen: ON” and press exit. The attenuation screen is now activated.
3. Press “set %” and by alternately pressing change and select, choose the percentage of the beam that you are measuring (in our example above you will set this to 005.000%). Now if you measure a value, the large display will show the value before attenuation and the small display will show the actual value measured. (In our example, the large display will show 100W and the small display 5W).

Note 1:

If the attenuation screen is activated, when the Nova is turned on it will come up in the attenuation screen. You may switch between the attenuation screen and the regular power or energy screen by pressing the menu button several times.

Note 2:

The attenuation screen can operate with both power and energy measurement.

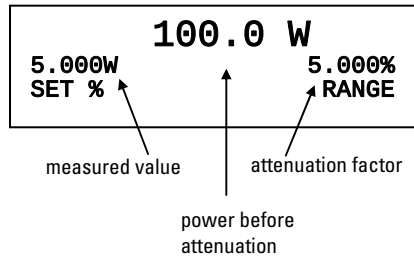


Figure 7
Attenuation Screen

4.5 Energy Measurement

4.5.1 Setup

Switch the Nova on. If it is in power mode, press the menu button once to make the legends visible and then press the left soft key "energy" to put it into energy mode. Alternately, if you remember the position, you can press the left soft key without pressing the mode button first. (See figure 8).

The energy mode is manual ranging: press "range" and then press the "up" and "down" soft keys to get to the proper range. The correct range is the lowest one which is larger than the pulse energy measured.

If you plan to use the same setting often, use the "configure" function as described in Section 4.3. before switching the Nova off the first time. When the Nova is switched on again, it will automatically go into the same mode until a different configuration is saved.

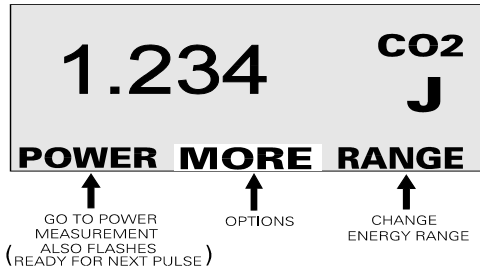


Figure 8
Energy Mode Screen

4.5.2 Measurement

To measure energy of a single pulse, set up as above and fire the laser. The display will go blank while the energy is being integrated. After 2-4 seconds, the correct energy will be displayed. When the Nova is ready to measure a new pulse, "ready" will appear on the screen and flash on and off. (See Figure 8). The next pulse will automatically blank the screen, and the new value will be displayed. If you fire another pulse before "ready" appears, the reading may be inaccurate or may not be displayed.

4.5.3 Minimum Energy Threshold

If the Nova is used in a noisy environment or where there is a high level of background thermal radiation, the instrument may trigger spuriously on the noise or background radiation. It would then fail to measure the intended pulse. Since there is always some degree of noise or background radiation, the instrument is designed not to respond to pulses below some preset minimum size.

This "Minimum Energy Threshold" is typically set to 0.3% of full scale of the selected range. If this level is found to be too sensitive for the user's particular environment, it may be altered by the user. The threshold should not, however, be raised higher than necessary. This will cause degradation in the accuracy of energy measurements of pulses below about 4 times the threshold level. The factory setting of energy threshold is "med" for medium. If the unit triggers on noise, set the threshold to "high." If you are measuring small energies and the unit does not trigger, set the threshold to "low."

To set the energy threshold:

1. From the energy measurement screen, press "more".
2. Press "select" until "threshold" is highlighted. Press "go". "Energy Threshold is Now med" will be displayed.
3. Press "value" to select "high," "med," or "low" threshold. For the 3A-P head "optical" is also available and is the default choice. (See below).
4. Press "exit" to return to main measurement screen. If you wish to save this value, "save all" with the configure function before switching the Nova off (Section 4.3).

Note (to users of 3A-P type heads):

The 3A-P type head has special circuitry enabling it to trigger on energy pulses of very low energy. This is accomplished by a special photodiode trigger which alerts the Nova that a pulse has been received and to start integration. This allows the 3A-P to react to smaller pulses than would be measurable just by triggering on the rising thermal signal as in other heads. When you select "optical" this enables the optical trigger. However, in some cases, the optical trigger will not work and you should select one of the thermal trigger settings, "low", "med" or "high". You should use thermal triggering on the 3A-P in the following cases:

1. The wavelength is outside the range of the of the photodiode, i.e. outside of 0.19 - 1.064µm
2. You are measuring the energy of a shuttered pulse of a continuous laser. In this case, the peak power is too low to trigger the photodiode.
3. For some other reason, the instrument does not trigger on the "optical" setting.

When using the optical trigger, the instrument should be able to measure down to 0.1 - 0.2 mJ, depending on wavelength. When using the thermal trigger (low, med or high), you should not attempt to measure less than about 1mJ.

4.5.4 Measuring Pulses of Very Low Energy

When it is necessary to measure pulses of very low energy, i.e., less than 0.5% of the maximum range of the instrument, the following two alternative methods allow greater accuracy to be obtained.

1. A continuous train of pulses may be fired, and the average power measured using "power" mode. The energy per pulse can be calculated by:

Energy per pulse = Average power / Pulse Repetition Rate

2. A train of a known number of pulses may be fired, and the total energy measured in "energy" mode. This train should not exceed 5 seconds duration. The energy per pulse can be calculated by:

Energy per pulse = Total Energy / Number of Pulses

In both of the above methods, the pulse repetition rate must exceed 3Hz. Higher rates will generally give improved accuracy, but care should be taken not to exceed maximum power ratings.

4.5.5 Measuring Energy of Rapidly Repeating Pulses

The standard Nova will only measure individual pulses every 5 seconds or so. You can also calculate the average energy of rapidly repeating pulses by measuring average power on the power setting and using the formula:

Average Energy per Pulse=Average Power/Pulse Repetition Rate

For rapidly repeating pulses, you can use one of the Ophir pyroelectric heads, as long as the pulse energies do not exceed the ratings of the pyroelectric absorbers. The pyroelectric heads are compatible with the Nova and just have to be plugged in to be used.

For higher pulse energies, you can use the Ophir model DGX-RP to measure both average power and exact individual pulse energy of the rapidly repeating pulses.

See your Ophir agent or sales representative for details.

4.5.6 Energy Log

The Nova has the option of displaying successive energy points in a vertical bargraph form. While measurements are being taken, the Nova will record data until the screen is full or "reset" is pressed.

An RS232 interface can be purchased to attach to a PC and then the data points can be transferred to PC either in real time or after storage. Contact your Ophir representative for details.

To use the Nova for graphical display of energy:

1. Make sure that the Nova is in the correct energy measurement range. If not, press "range", adjust and press "exit".
2. From the energy measurement screen press "more" and then select "energy log". Press "go". The histogram screen will appear. Now fire a pulse when the "ready" legend flashes. The measurement will immediately begin. When the screen is full, the measurement will stop and the graph will continue to be displayed.

Warning:

Pressing "reset" will erase all previously stored data and start recording new data.

3. The left button is the "reset" button. Press this button to reset the screen and begin a new measurement. While pressing the button, the legend "reset" is visible.
4. If you wish to see finer variations in the graph, press the center "zoom" button.

Note:

Zoom can only be pressed after at least one pulse has been recorded.

5. To return to the main energy measurement screen, press "exit".

Chapter 5 Operation with Photodiode Type Heads

Warning:

Before using the head for power or energy measurement, check that your laser power or energy and energy density does not exceed the head ratings. See table 6.

5.1 Photodiode Heads

When a photon source, such as laser, is directed at one of the PD300, 3A-IS or BC20 series photodiode detectors, a current is created proportional to the light intensity and dependent on the wavelength.

The PD300, PD300-3W and BC20 heads have a unique dual detector head (patented) in which the two detectors are identical and connected back to back. When a uniform signal, such as room light background, falls on the detector head the signal from the two detectors cancels.

On the other hand, when a laser beam falls on the head, it illuminates only the first detector and therefore is detected. Thus the PD300 subtracts most of the background while detecting the desired signal. The subtraction is not perfect but usually 98% of the background signal is eliminated so the detector can usually be used in ordinary laboratory lighting conditions.

The Nova display unit amplifies this signal and indicates the power level received by the head. Due to the superior circuitry of the Nova, the noise level is very low, and the PD300 series heads with the Nova display have a large dynamic range from nanowatts to hundreds of milliwatts. Since many low power lasers have powers on the order of 5 to 30mW, and most photodiode detectors saturate at about 2mw, most heads of the PD300 series have been constructed with a built in filter so the basic head can measure to 30mW or more without saturation. When the additional filter is installed, the maximum power is on the order of 300mW or 3W with model PD300-3W.

The PD300 saturates when the output current exceeds 1.3mA so the exact maximum power depends on the sensitivity of the detector at the wavelength used. When saturated the legend "SAT" will appear on the screen. Table 2 gives the actual maximum power as a function of wavelength.

FILTER OUT

WAVE--LENGTH	PD300	PD300-3W	PD300-UV	3A-IS	WAVE-LENGTH	PD300-IR
250-350nm	N.A.	N.A.	1mW	N.A.	800nm	20mW
400nm	30mW	30mW	3mW	N.A.	1-1.3µm	30mW
633nm	20mW	20mW	3mW	1W	1.4µm	25mW
670nm	13mW	13mW	3mW	2W	1.5µm	15mW
800nm	10mW	10mW	2.5mW	3W	1.6µm	10mW
900mm	10mW	10mW	2.5mW	3W	1.8µm	25mW
1060nm	25mW	25mW	3mW	3W		

FILTER IN

WAVE--LENGTH	PD300	PD300-3W	PD300-UV	3A-IS	WAVE-LENGTH	PD300-IR
250-350nm	N.A.	N.A.	100mW	N.A.	800nm	200mW
400nm	300mW	3W	300mW	N.A.	1-1.3µm	300mW
633nm	300mW	3W	300mW	N.A.	1.4µm	150mW
670nm	200mW	3W	300mW	N.A.	1.5µm	80mW
800nm	100mW	1W	250mW	N.A.	1.6µm	50mW
900mm	150mW	1.5W	250mW	N.A.	1.8µm	100mW
1060nm	250mW	2.5W	300mW	N.A.		

Table 2.
Maximum Measurable Laser Power as a Function of Wavelength

5.2 Setting up the PD300 and 3A-IS to display the user's chosen wavelengths

The PD300 and 3A-IS series have built in wavelength correction curves for measurements either with the removable filter installed (filter-in) or removed (filter-out). These curves are stored in the head EEROM. the correction curves, with a resolution of 1nm, ensure that the power reading is correct at all laser wavelengths.

In order to simplify changing from one laser wavelength to another, the user can program up to 6 different wavelengths to be available from the screen menu. Please use the following procedure to set the PD300 to your laser wavelengths.

1. From the power measurement mode with the bargraph display, press the menu button located on the right side until "more" appears. Press "more".
2. Press "select" until "wavelength" is highlighted. Press "go".
3. Press "change" then "up" and "down" to select the first wavelength desired. Press "done". Repeat steps 2 and 3 for other wavelengths desired. When finished press exit and the new values will be saved.

5.3 Startup Defaults

If you are planning to do similar measurements most of the time, you can set up the Nova so that it automatically goes into the measurement mode you want upon startup. Since these desired settings are saved in the head "smart connector", you can save different settings for different heads. The following section describes how to set up the Nova with photodiode heads so that they will start up in the desired configuration.

Setting up the startup defaults:

1. From the power measurement bargraph screen, press the menu button located on the right side until "more" appears. Press "more".
2. Press "select" until "configure" is highlighted. Press "go".
3. Press "value" to select filter in or out as the startup default. For details of filter in/out See Section 5.4.3.
4. Press "select" then "value" to choose the manual power range you wish to be the default, autorange or dBm. The Nova will now be in the mode selected when switched on with this head connected.
5. Now press "select" and "value" again to choose the default laser wavelength.
6. Press "exit" when all selections have been made and press "all" to save all current Nova settings. If you only want to save the last changes made on the previous screen, press "previous screen".

5.4 Selecting Settings from the Nova Screen

The Nova can conveniently be set to various chosen parameters from the screen. In addition these settings can be saved as startup defaults so the head will be in the desired configuration when turned on.

5.4.1 To Set to the Laser Wavelength Being Used

Photodiode heads have a different sensitivity at different wavelengths. Moreover, the filters used in the head have a different transmission at different wavelengths. In order to compensate for this, each head has a built in calibration curve (with 1nm resolution) over the measurement range.
When you choose the correct laser wavelength, the correction factor for that wavelength is automatically introduced. Note that the laser wavelength presently corrected for is displayed in the upper right corner of the display. In order to define the laser wavelengths to choose from, See Section 5.2.

In order to choose the laser wavelength, do the following:

1. From the bargraph measurement screen, press the menu button twice and press "laser" until the correct laser type or wavelength is displayed.
2. Return to bargraph screen by pressing the menu button again.

5.4.2 To choose Manual or Automatic Ranging or dBm

Autorange - The Nova allows you to choose autorange or manual ranging when the reading is in watts. In autorange mode, you do not have to change scales. When the reading of the meter or bar is more than 100% of full scale, the range goes to the next higher one. When the reading falls below 90% of full scale, the range changes to one range lower. This change occurs after a short delay. This provides overlap (hysteresis) to keep the Nova from flipping back and forth when reading close to the end of the scale.

Manual Range - There are certain disadvantages to autorange since it changes scale even if you don't want it to do so. If you want to measure the same range all the time, it is better to use manual range. The correct range to select is the lowest one which is larger than the largest expected measurement. If you wish the Nova to be in manual mode when switched on, save this configuration before switching off. See Section 5.3.

dBm - The Nova allows the measurement to be made in units of dBm which is a logarithmic scale. dBm units are defined as:

$10 \times \log_{10}$(reading in mW)

At 1mW the reading will be 0 dBm, at 100mW it will be 20 dBm etc.

To choose auto, manual or dBm range, follow these steps:

1. From the bargraph measurement screen, press the menu button once.
2. Press "range" and then select the appropriate manual range, autorange or dBm by pressing the "up" or "down" buttons.
3. Press "exit" and then press the menu button twice to return to the bargraph measurement screen.

Measuring loss using the dB offset function:

Since dBm is a logarithmic measurement, the ratio between two measurements will be the difference between the dBm measurements. For instance, if you want to measure the loss in a fiber optic cable where the measurement before the cable is:
1mW = 0dBm
and the measurement after the cable is:
0.1mW = -10dBm.
The ratio is then 1:10 = 0.1 and the dB loss is:
0 – (-10) = 10dB.
The dB offset function allows you to easily measure this. To do so do as follows:

1. When measuring the reference value press “dbofst”. The value changes to 0 dB (note that now the units are dB, a relative value instead of dBm, an absolute value).

2. Now make your second measurement and the value of the difference in dB = ratio in numerical units will be shown.

Note:

If there is a zero offset in the reference value, you cannot subtract this using the DBOFST function. Instead, before the start of the measurement, go into a numerical scale, press “offset” and subtract the zero offset. Then go into the dBm scale and follow steps 1 and 2 above. The zero offset activated in the numerical scale will be saved in the dBm scale and you can now use the DBOFST setting to measure true ratio without zero offset problems.

5.4.3 Operation with Filter In or Out

The PD300 head is equipped with a built in filter so that the photodiode can measure up to 30mW without saturating the detector. In addition, the PD300 comes with an additional removable filter for measuring up to 300mW. Other models of the PD300 series also have built-in and removable filters. The exact maximum power is reached when the reading reaches full scale or the output current from the head reaches 1.3mA, whichever comes first. See Table 2 for the exact maximum as a function of wavelength.

Depending on what powers you wish to measure, you should choose to work with the removable filter installed or not. For this purpose, the Nova has a "filter" setting and uses the proper correction curve depending on whether the filter is installed or not.

Warning:

If the PD300 is used in the "filter in" setting and the filter is not installed or vice versa the readings will be completely incorrect.

If the power of your laser exceeds the maximum for filter in, you can purchase a thermal head for that wavelength. Consult your Ophir agent for details.

To choose the filter setting:

1. From the bargraph measurement screen press the menu button twice.
2. Press "filter" .
3. If you wish to work with filter installed, press "change" until display says "filter is in". Be sure to install removable filter on detector head.
4. If you wish to work with the filter out, press "change" until display says "filter is out". Be sure to remove the filter from the detector head.
5. When finished press exit to return to the measurement screen.

5.4.4 Zoom

The Zoom function causes the scale to expand around the present reading ±10%. Thus, if the full scale of the bargraph is 20mW and your reading is 15mW, pressing "zoom" will make the bargraph scale range between approximately 13.5 and 16.5 mW.

Variations in power are more easily seen in this mode. When zoom is engaged, the legend is highlighted. To cancel the zoom function, press "zoom" again. The zoom function can be useful for laser power tuning and peaking.

To access the zoom function, press the menu button until "zoom" appears. Then press "zoom". When it is highlighted it is engaged. Now press the menu button twice again to return to the bargraph power display. Note that the fiducial marks of the bargraph are further apart, indicating that zoom is engaged. You may also directly engage the zoom function from the bargraph screen by pressing the middle button. Note that while the button is pressed, the soft key legend appears. Pressing "zoom" again will cancel the function.

5.4.5 Offset

The PD300, PD300-3W and BC20 heads have automatic background subtraction as described in Section 5.1. In addition, the offset function can be used to subtract the residual background signal which remains if desired. If the Nova shows a nonzero power reading even when there is no laser, you can subtract the background using the zero function. For example, the Nova display reads 0.1mW when the laser is blocked and 20.5 mW with laser power applied. In this case, the true power is:
20.5 - 0.1 = 20.4 mW.
To subtract the background, press the menu button until "offset" appears and press "offset" while the laser is blocked. The Nova will now read zero (0.0), and the 0.1 mW background will be subtracted from all subsequent readings. The laser power reading will thus be 20.4 mW.

When "offset" is engaged, the legend is highlighted. To cancel, press "offset" again. If the "offset" is engaged, and you wish to subtract a new value of the background, press "offset" twice. The first press will cancel the old value, and the second will activate a new value. If you suspect that the Nova has a permanent zero offset, then disconnect the head while it is in the power measurement mode. If the Nova still shows a nonzero reading even when the head is not connected, the instrument internal zero should be reset. See section 3.5.2.

5.4.6 Tune and Powerlog

The Tune function, an exclusive Ophir option, makes adjusting your laser to its maximum power easier than ever before. Unlike a bargraph or mechanical meter, this display shows graphically what came before as well as the current reading and the trend. This allows you to see at a glance if you have reached maximum power.

The Nova also has the option of graphing the laser power vs. time, or successive energy points as long as the Nova has not been turned off. While measurements are being taken, the Nova will record data until the screen is full, or "reset" or "exit" is pressed.

5.4.7 Average and Measuring Very Low Power Measurement

If the laser power is fluctuating, the Nova can display the average power readings with averaging periods varying from 1/3s to 1 hour. When measuring very low powers, such as picowatt measurements using the PD300-IRG or PD300-UV, there will be a rather large zero offset coming from the detector as well as a considerable noise fluctuation. Nevertheless, you can measure these low values by using the average function and pressing offset to eliminate the detector zero offset. In order to measure very low powers do as follows:

1. Select the lowest manual power range which is larger than the value you wish to measure.
2. Go into the average screen by pressing the menu button twice then “more” then selecting “average” and pressing “go”.
3. Select average over the appropriate period in seconds and press “go”.
4. Now block the power source you wish to measure, wait for a few measurement periods and press “offset” to subtract the zero offset.
5. Now unblock the power source and measure.
   For more about the average function See Sections 4.4.2.5.

Note:

The average function does not work with autorange or dBm scales.

5.5 BC20 Heads for Scanned Beams

Note:

Many of the functions of the BC20 head are the same as the PD300. This section only describes the PD300 functions which are different from ordinary PD300 functions. For standard PD300 functions, please refer to the rest of chapter 5.

5.5.1 General Description

Model BC20 scanned beam laser power meter has become the industry standard for measuring scanned laser beams as well as hard to reach static beams. The BC20 smart head has built into its smart plug innovative circuitry to measure scanned as well as static beams of up to 20 milliwatts with a noise level of microwatts.

The BC20 has the same patented dynamic background subtraction as the PD300 which eliminates over 95% of background light and allows measurement in normal room light.

5.5.2 Setting up the startup defaults

1. From the power measurement bargraph screen, press the menu button located on the right side until "more" appears. Press "more".
2. Press "select" until "configure" is highlighted. Press "go".
3. Press "select" then "value" to choose whether you want the instrument to operate in “continuous” or “hold” mode. In continuous mode, the peak reading of every 1/3 sec period is displayed and in “hold” mode, the peak reading of every 5s period is displayed.

Note:
Do not use autorange when in hold mode.

4. Now press "select" and "value" again to choose the default laser wavelength and the default power range.
5. Press "exit" when all selections have been made and press "all" to save all current Nova settings. If you only want to save the last changes made on the previous screen, press "previous screen".

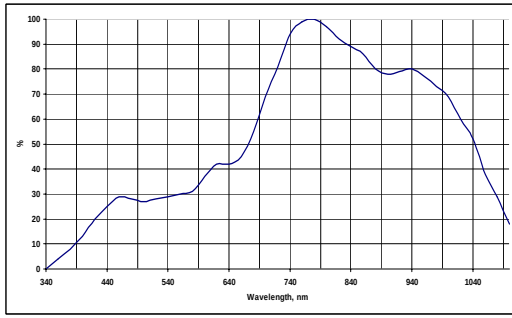
5.5.3 Measuring Scanned Beams with the BC20

1. Verify that the head is plugged in.
2. Set to the proper power range or autorange.

3. Set up the startup defaults and choose "continuous" if you want continuous readings or "hold" if you want readings to be held for 5s before updating. (See section 5.5.2 above).
4. Hold the wand so the beam strikes the detector vertically. While the beam is scanning, move the scanner slightly up and down in a direction perpendicular to the scan direction so that the scanned beam is sure to cross the center of the detector. (The BC20 captures the highest reading so that the most accurate results are obtained if the beam scans across the center of the detector). The unit will also measure static beams as would a normal laser power meter.

5.5.4 Spectral Response

A graph of the approximate relative spectral response of the BC20 is given for purpose of interpolation. This is in case the user wishes to use the instrument at a wavelength other than the ones which are factory calibrated.



5.6 Special Photodiode Heads

5.6.1 PD 300-BB Radiometer Head

In addition to photodiode head for individual wavelength, Ophir also supplies heads for measuring the output of broadband light sources. The PD300-BB head has spectrally flat response from 400 to 1000 nm and therefore can give the true total power of any broadband light source in that spectral region.

Note:

Because the BB heads are spectrally flat, wavelength selection is disabled. Other than that, operation is the same as other PD300 type heads.

5.6.2 PD300-CIE Photometer Head

The PD300-CIE head has a spectral response similar to that of human eye and can therefore make measurements in eye response units of Lux. The PD300-CIE is designed with a small detector where the source overfills the detector. It measures the light intensity per unit area in units of Lux or Foot Candles.

Note:

Because the CIE heads have a spectral response similar to the human eye wavelength selection is disabled. Other than that, operation is the same as other PD300 type heads.

Chapter 6 Operation with Pyroelectric and Photodiode Energy Heads

Warning:

Before using the head for power or energy measurement, check that your laser power, energy or energy density do not exceed the head ratings as listed in the table with the head specifications. Otherwise, there is a risk of damaging the absorber.

With the pyroelectric head, you have been supplied a test slide with the same coating as on your pyroelectric detector. You can also obtain this slide from your dealer. You should use this slide to test the damage threshold with your laser pulses. If the slide is damaged, then either enlarge your beam or lower the laser energy until damage is no longer seen.

6.1 Pyroelectric and Photodiode Energy Detector Heads

When a pulsed heat source, such as a laser, is directed at the detector head, a temperature gradient is created across the pyroelectric crystal mounted in the head. An electric charge is produced which is proportional to the energy absorbed. The detector head has sophisticated circuitry unique to Ophir (patent applied for) which determines the baseline before the pulse is received, measures the voltage after a pre-determined interval, amplifies it and holds it for a pre-determined time.

Due to this innovative circuitry, Ophir pyroelectric heads can measure very long pulses as well as short ones. They can measure low energies as well as high. They can also measure at higher repetition rates than was possible before.

The Nova display amplifies this signal and indicates the energy received by the head as well as the frequency at which the laser is pulsing. Using the energy and frequency information, the Nova is also able to display average power.

The photodiode based PD10 head also uses the same circuitry but can measure much lower energies due to the sensitivity of the photodiode.

6.2 Selecting Settings from the Nova Screen

The Nova can conveniently be set to various chosen parameters from the screen. In addition, it can be set to startup defaults so it will be in the desired configuration when turned on.

6.2.1 Setting up the head to display the user's chosen wavelengths

The sensitivity of the detector varies somewhat with wavelength. The correction curve for the absorber is stored in the head EEROM. This correction curve ensures that the power reading is correct at all laser wavelengths.

In order to simplify changing from one laser wavelength to another, the user can program up to 6 different wavelengths to be available from the screen menu. Please use the following procedure to set the pyroelectric or PD10 head to your laser wavelengths.

1. From the bargraph display, press the menu button located on the right side until "more" appears. Press "more".
2. Press "select" until "wavelength" is highlighted. Press "go".
3. Press "select", "change" then "up" and "down" to change the first wavelength desired. Press "done". Repeat for other wavelengths desired up to 6. Now press exit.
4. Now press "more" then "select" until "config" is highlighted. Press "go", "exit" then "all" to save the wavelengths you have set. If you wish to save other defaults in the "config" screen, See Section 6.3.

Note:

The broadband type heads (BB) have less variation with wavelength, and in those heads, fixed wavelength ranges are selected similar to thermal heads. This section is not relevant with those heads.

6.2.2 Setup of Laser Pulse Length and Pulses / Sample

6.2.2.1 Laser Pulse Length

As was mentioned before, the Ophir pyroelectric heads can measure long as well as short pulses. In order to do this, the user must indicate to the Nova if the laser pulses are going to be longer or shorter than the maximum wavelength in the short pulse mode. (Some models only have only one maximum pulse length setting which is usually 3ms. In that case, "N.A." for not applicable appears and the setting cannot be changed).

Warning:

If the pulse length is incorrectly set to the short pulse setting for long pulses, the reading will be erroneously low. If it is set to the long pulse setting for short pulses the reading will be correct but noisy.

To set up for pulse length, please do the following:

1. From the bargraph measurement screen, press the menu button twice and press "setup".
2. Now press "value" to select proper setting for your laser pulse length. If your laser pulses are longer than the short pulse setting, then the long pulse setting should be selected and if shorter, then the short setting should be selected.

6.2.2.2 Setup for Number of Pulses per Sample

The Nova has the ability to measure a number of pulses and display the average value of the energy of the pulses. This function is useful if the laser energy is not stable. Then the user can choose to measure a number of pulses and display only the average.

Note:

The Pyroelectric and photodiode energy heads are capable of measuring pulses up to very high repetition rates on the order of kilohertz or above.

However, at high repetition rates, the display can capture the pulses at rates not exceeding 15Hz. The Nova samples individual pulses at a rate of 15Hz from the laser pulse train. Thus if the user has a laser pulsing at over 15Hz and wishes to average over a number of pulses, the average will be over the number of pulses processed by the Nova and not over those emitted by the laser.

Example:

If the user's laser is pulsing at 300Hz, and the user selects to average over 1s, the Nova will collect 15 pulses of the 300 emitted during that period, and will average over those 15 pulses. The Nova will then update the display every 1s.

To set up for averaging over a number of pulses:

1. From the bargraph measurement screen, press the menu button twice and press "setup".
2. Now press "select" until "average over" is highlighted. Now press "value" until the time period you wish to average over is displayed. If you do not want to average, but collect individual pulses then select "none".
3. Press "exit". If you wish to save the new setting, follow the instructions in section 6.3.

Note:

The average function only affects the numerical readings on the screen. The bargraph always shows individual pulses.

6.2.2.3 PD10 Photodiode Energy Head

The PD10 operates in a similar fashion to the pyroelectric PE heads except it has a photodiode detector instead of pyroelectric. Because of its great sensitivity, it can operate down to about 1nJ of energy. It has complete wavelength correction over its entire measurement range of 200 - 1100nm.

The PD10 operates in a similar fashion to the PE head except that it has one extra function. When measuring very low energies, the head will also be sensitive to background light and therefore show a spuriously high reading. Therefore we have added a function to measure the background light. When measuring low energies, block the laser and press “bkgrnd”.
You will see a reading of the background light. This reading can be subtracted from your laser reading to obtain a more accurate reading. Also, making the room darker will reduce this background effect.

6.2.2.4 PE -DIF diffuser heads

PE50BB-DIF and PE50-DIF-ER heads with removable diffusers have to be set up properly to operate with the diffuser IN or OUT. Since the wavelength settings with diffuser in are not the same as with diffuser out, **two things must be changed every time the head is changed from diffuser IN to OUT. (in addition to changing the pulse length setting if necessary).**

To change from diffuser OUT to IN and back:

1. Press the menu button twice and press “setup”.
2. Press “select” until the diffuser setting is highlighted and select “IN” or “OUT” as desired. Make sure the diffuser is physically installed or not installed on the head. Press exit.
3. Press the menu button twice and press “laser” until the correct wavelength is selected. Note that only wavelengths compatible with the diffuser setting are visible. (All wavelengths for diffuser IN have a D suffix, e.g. 106D = 1.06μm, diffuser in).
4. If it is necessary to change the pulse length setting, from the bargraph screen press the menu button twice, press “setup” and press “value” to choose the correct pulse length. Then press exit.
5. If you wish to save these settings as the defaults, from the main display, press the menu button twice then press “more”. Select “config” and make sure the settings are those you want. Press “exit” and “all” to save all present settings including diffuser IN or OUT and pulse length setting.

6.3 Startup and Configuration of Defaults

If you are planning to do repetitive measurements most of the time, you can set up the Nova so that it automatically goes into the measurement mode you want upon startup.
Since these desired settings are saved in the head "smart connector", you can save different settings for different heads.

To set the Nova to start up in power or energy measuring mode and to save the chosen Nova configuration:

1. From the bargraph measurement screen, press the menu button located on the right side until "more" appears. Press "more".
2. Press "select" until "config" is highlighted. Press "go".
3. Press "value" to choose "power" or "energy" for the desired startup screen. The Nova will now start up in power or energy measurement mode, respectively, when switched on.
4. Press "select" until the laser wavelength is highlighted. Now press value to select the laser wavelength you want to be the default. The Nova will now be correctly calibrated for the absorption of the detector at the wavelength of the laser type selected. If you wish to choose another wavelength, See Section 6.2.1.
5. Press "select" and "value" to choose the default pulse length and energy range.
6. Now press exit when all selections have been made. Now press "all" if you want to save all current settings, or "previous screen" if you want to save only the settings previously set.
7. In addition to the choices made above, the Nova will now save all other functions as they have been chosen at this point, such as laser pulse width, number of pulses for average, power and energy graph settings and so forth. Therefore, before this point, it is best to set up all other functions also.

6.4 Energy, Power or Exposure Measurement

Warning:

Before using the head for power or energy measurement, check that your laser energy, energy density and average power do not exceed the head ratings as listed in the table with the head specifications at the end of the manual, otherwise, there is a risk of damaging the absorber. With the pyroelectric head, you have been supplied a test slide with the same coating as on your pyroelectric detector. You can also obtain this slide from your dealer. You should use this slide to test the damage threshold with your laser pulses. If the slide is damaged, then either enlarge your beam or lower the laser energy until damage is no longer seen.

Note:

To measure pyroelectric energies properly, it is important that the head is not grounded to the optical bench. Make sure that the head is isolated electrically from the ground. The PE head has been supplied with an insulating mounting post for this purpose.

6.4.1 Energy Average Power and Frequency Measurement

Unlike most pyroelectric and photodiode energy meters, the Nova measures the pulse frequency to a high degree of accuracy and is therefore able to display pulse frequency and average power as well as pulse energy. The following paragraph will describe how to set up and measure these functions.

6.4.1.1 Energy Measurement

Ordinarily, when the instrument is switched on, it is in the bargraph energy measurement mode. This can be verified by the fiducial marks at the bottom of the screen and the units of mJ, µJ etc. (See figure 9).

How to set up for pulse energy measurement is described below.

1. Make sure the instrument is in the bargraph energy measurement mode indicated by the fiducial marks at the bottom of the screen and the units of mJ, µJ, etc. If it is in power measurement mode with units of mW, W etc, then press the left soft key or alternatively, press the menu button and then the left "energy" soft key. The Nova can be setup to start up in energy or power measurement mode when turned on. See section 6.3.

Figure 9
Pyroelectronic and Photodiode Head Energy Screen

2. Press the menu button once then press "range" then the "up" "down" soft keys until the proper range is highlighted. The correct range is the lowest one that is larger than the pulse energy measured.
3. Press exit then press the menu button twice to return to the bargraph measurement screen. If you wish to have the frequency displayed, press the menu button only once.
4. If you wish to display the average of a number of pulses, press the menu button until "setup" is seen. Press "setup" and then "select" until "pulses/sample" is highlighted. Press "value" to select the number of pulses you wish to average over. This function can be permanently saved. See also Section 6.2.2.2. and 6.3.

The Nova is now ready to measure energy pulses. The energy reading will operate in the following manner if "none" selected as the averaging period, following every 1/15th of a second period, the Nova will display on the screen the next pulse which arrives. The Nova will hold the display of the latest pulse until a new one arrives. If an averaging period is selected, the Nova will collect pulses at up to 15Hz and will then display the average of those pulses. When a new pulse triggers the Nova, a "T" will appear in the upper left corner of the screen. At over 5 Hg, the "T" stops flashing and appears all the time.

6.4.1.2 Minimum Energy Threshold

If the pyroelectric heads are used in a electrically or acoustically noisy environment the instrument may trigger spuriously. It will then display a spurious pulse. Since there is always some degree of noise or background, the instrument is designed not to respond to pulses below some preset minimum size. This "Minimum Energy Threshold" is typically set to 4% of full scale of the selected range. Pulses which are very close to background may read sporadically or inaccurately. Therefore it is important to always use the lowest energy range which is larger than the energies you are measuring.

6.4.1.3 Power Measurement

1. Make sure the instrument is in the bargraph power measurement mode indicated by the fiducial marks at the bottom of the screen and the units of mW, W, etc. If it is in energy measurement mode with units of mJ, µJ etc, then press the left soft key or alternatively, press the menu button and then the left "power" soft key. The Nova can be configured to start up in power measurement mode when turned on. See section 6.3.
2. Press the menu button once then press "range" then the "up" "down" soft keys until the proper range is highlighted.

The correct range is the lowest one that is larger than the highest energy being measured. Note that the proper range is related to the pulse energy even though we are measuring average power.

3. Press exit then press the menu button twice to return to the bargraph measurement screen. If you wish to have the frequency displayed, press the menu button only once.

6.4.2 Zoom

The Zoom function causes the scale to expand around the present reading ±10%. Thus, if the full scale of the bargraph is 25mJ and your reading is 15mJ, pressing "zoom" will make the bargraph scale range between approximately 13.5 and 16.5 mJ. Variations in energy or power are more easily seen in this mode. When zoom is engaged, the legend is highlighted. To cancel the zoom function, press "zoom" again. The zoom function can be useful for laser power tuning and peaking.

To access the zoom function, press the menu button until "zoom" appears. Then press "zoom". When it is highlighted it is engaged. Now press the menu button twice to return to the bargraph power display. Note that the fiducial marks of the bargraph are further apart, indicating that zoom is engaged. You may also directly engage the zoom function from the bargraph screen by pressing the middle button.

Note:

While the button is pressed, the soft key legend appears. Pressing "zoom" again will cancel the function.

6.4.3 Measuring Total Energy Exposure.

The Nova has the ability to sum the total energy of a number of pulses over a given time period or number of pulses. This gives the total energy "exposure" over that time period. For example if the laser is pulsing at 30 times/s at 1mJ per pulse and you measure the exposure over 20 seconds then the total exposure is 30 x 1 x 20 = 600mJ

In order to measure exposure, do the following:

1. Press the menu button until "more" appears. Press "more".
2. Press "select" until "exposure" is highlighted. Press "go".
3. Setup the desired measurement parameters in the setup screen and press "go".
4. Press "go" again. The Nova will start summing laser energy exposure and the legend will change to "stop". When you wish to stop measuring, press "stop" or wait for the timeout selected in the setup screen. The Nova will now display the total energy emitted during that period, the time elapsed and the number of pulses during the period. If you wish to reset reading to zero before another reading, press "reset".
5. To return to the bargraph screen, press exit.

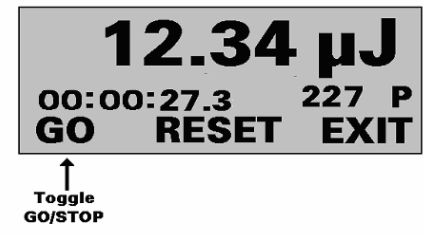


Figure 10.
Exposure Screen

6.4.4 Pyro Scope Adapter

A special adapter can be purchased which is plugged in between the head connector and the Nova head socket. This adapter has a cable and BNC connector to attach to an oscilloscope. It enables the user to see on the scope pulses proportional to energy up to the maximum pulse rating of the head . Unlike the Nova display, which samples at the maximum rate, the scope adapter shows every single pulse.

Activate the scope adapter as follows:

1. Plug the adapter into the Nova display and then plug the head plug into the adapter. Plug the BNC connector into a standard 1MΩ scope input.
2. Press the menu button twice and then press 'more". Select "scope" and press "go". The display will now say "in scope mode". Select the appropriate measurement range in the usual way.
3. You can return to the ordinary measurement mode by pressing "exit" from the scope mode screen.
4. If you wish the instrument to start up in scope mode, press the menu button twice and press 'more". Select "config" and press "go". Select "display" and press "value". It will change to "scope". Press "exit" and "all" to save the new configuration.

6.5 Measuring Repeating Pulses of High Energy

Because of their construction, pyroelectric heads are restricted in the energy density they can withstand, particularly for short pulses on the order of nanoseconds. If the energy density of your laser exceeds the rating of the pyroelectric absorber, there are several options available.

1. You can use Pyroelectric heads with a diffuser. Ophir has several heads with a diffuser which increases the damage threshold by an order of magnitude. (See table 7 at the end of this manual).
2. You can enlarge your laser beam using a negative lens until the energy density is below damage threshold. You should test this using the test slide. See section 6.4.
3. You can use the Ophir beam splitter which mounts the PE heads and splits off typically 8 -10% of the light. If you use this method, note that there may be polarization effects. You can calibrate the beam splitter by running the laser at an energy below damage threshold and measuring the energy with and without the beam splitter. The Ophir beam splitter is built to facilitate this measurement.
4. Ophir has models RP which are specifically designed for pulses with energies up to 100 Joule/cm^2.

Contact your Ophir dealer for details.

6.6 Energy Log

This is the same as for thermal heads, except you do not have to wait for "reset",
See section 4.5.6.

Chapter 7 Circuit Description

The NOVA has three circuit boards: an analog processor, a digital processor and a power supply.

Analog Processor:

The signal from the detector head enters the analog processor board and passes through EMI protection components to a differential transimpedance preamplifier. From there it is further amplified by a programmable gain voltage amplifier and passes to a dual slope integrating analog to digital converter. All calibration data for the analog processor is stored on a memory chip on the analog processor board. There are no adjustable components (trimmers etc.) in the NOVA except for the display contrast adjustment on the rear panel.

Digital Processor:

The digital processor is built around a Motorola MC68332 32-bit central processing unit (CPU) with a 16-bit bus. On the digital processor board there is a socket containing the upgradeable program ROM and a 256Kbit static RAM.
The processor receives signals from the analog processor and converts them into current in amps. When used with thermopile heads the signal is then processed by a sophisticated digital filter which speeds up the effective response time of the head and rejects noise. The digital processor is also responsible for controlling the analog processor, reading the keypad, and driving the display.
The CPU obtains calibration and capability data from a memory chip in the plug of the detector head and configures itself accordingly. Recalibration data and saved settings are also stored in this memory chip.

Power Supply:

The power supply board, which also holds the display module and the keypad switches, provides the internal DC voltages for the analog and digital processors. It also contains the battery charging circuit and the AC supply for the backlight. All of the power supplies operate in switch mode with an oscillator frequency of 32KHz.

Electromagnetic Interference:

The Nova and associated heads have extensive circuitry both to reject outside electromagnetic and electrostatic interference. The Nova and associated heads are fully CE qualified and are extremely resistant to EMI. If there is still some interference in an unusually high EMI environment, it is recommended to use the Nova without the charger plugged in.

Chapter 8 Calibration, Maintenance and Troubleshooting

8.1 Calibration of Thermopile Heads

8.1.1 Absorber types and Method of Calibration of Ophir Power Meters

8.1.1.1 Types of Ophir Laser Absorbers

Two types of absorber surface are used in Ophir thermal measuring heads.

1. Surface Absorbers:

BB (broadband) absorber:

On standard, high power density, broadband Ophir power monitor heads, a special refractory coating is used to provide high absorptivity from the UV through the IR. This coating can withstand very high power densities, up to 20 kW/cm², without changing calibration. The absorption of this coating is above 90% for most of its range, as shown in Graph 1 below.

EX (excimer) absorber :

The EX absorber provides high absorption in the UV, and it can withstand both the pulse energies and the average power of excimer lasers. These discs also have excellent absorption for 10.6 µm and other wavelengths. They can therefore be used for other types of lasers as well. The absorption of the various Ophir absorbers as a function of wavelength is shown in Graph 1 below.

LP (long pulse) absorber:

This absorber has a particularly high damage threshold for long pulse (ms) or continuous lasers and is therefore offered for use with high power heads. It is calibrated for use with YAG laser at 1.064µm or CO_2 laser at 10.6µm and absorbs about 90% at these wavelengths.

2. Volume absorbers

P (pulse) type absorber:

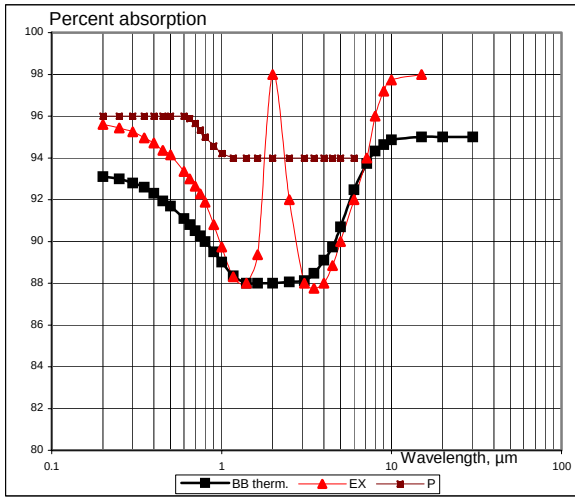
The models with the P suffix, for use with pulsed lasers, have a special absorbing glass with an absorbance of 95 $\pm$2% over the operating range. Since the surface is a glass, its reflectivity does not change even if damaged or melted locally.

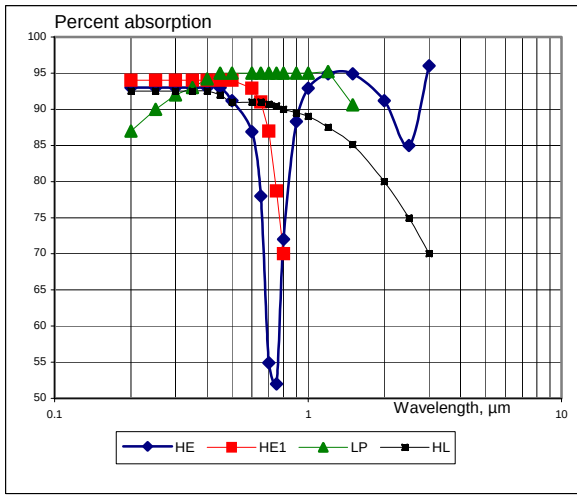
HE/HE1 (high energy) absorber:

The HE and HE1 types have a particularly high damage threshold for pulsed and repetitively pulsed lasers of both the short and long pulse variety and are useful where the highest pulse energies and average powers are used.

HL (high energy long pulse) absorber:

The HL absorber is the absorber of choice for high energy repetitive pulses longer than 2ms. For these long pulses it has flatter spectral response than the HE/HE1 and withstands higher pulse energy and average power.





Graph 1.
Absorption of Ophir Thermal Absorbers vs. Wavelength

8.1.1.2 Method of Calibration

The absorption of the various Ophir thermal absorbers can vary from disc to disc. Therefore, all Ophir absorbers are individually calibrated against NIST traceable standards.

Ophir power/energy meters with the broadband or P type absorbers are individually calibrated by laser at several wavelengths against a NIST calibrated standard meter. The meter can be switched to give the exact calibration at the various wavelengths (Argon, YAG, and, where applicable, CO2); or, for some models, an average value is given.
The EX type detector is calibrated by measuring the ratio of absorption in the UV to that at 515nm. The total absorption is measured in both cases using an integrating sphere. The detector is then calibrated with an argon laser and given a correction factor from this ratio.

8.1.2 Linearity and Accuracy of Ophir Thermal Heads

8.1.2.1 Linearity

The linearity of most Ophir thermal detectors is specified to be 1% over the specified power range of each particular instrument. The linearity is tested by electrical substitution heating. Models of up to 30 watts maximum rating are subjected to electrical input up to their maximum rating, models of up to 300W maximum rating are heated up to 100 watts, and models of 1000W rating and above are heated up to 200 watts. On CAL models, the built in CAL resistor is used.

On non CAL models, a CAL resistor is temporarily affixed to the sensor. For those models for which the linearity is not tested over their entire range, randomly chosen sample models are tested periodically over their entire range.

The test is performed with a high power laser that can cover the entire detector range using a rear leak detector for comparison. This rear leak detector is a low power Ophir detector which has previously been tested for linearity. Thus, in all cases, the linearity of the detectors is traceable to electrical standards.

8.1.2.2 Total Accuracy of Calibration

Since the instruments are calibrated against NIST standards, the accuracy is generally 1% at the power level at which the calibration has been performed. This accuracy has been verified by checking the scatter of the results when several instruments are calibrated against the same standard. The maximum error in measurement will be less than the sum of the specified accuracy and linearity. Since the linearity is also 1%, the maximum error in measurement will generally be less than 2%.

8.1.3 Calibration Factor

For models equipped with the Ophir CAL resistor, the calibration factor is determined at the factory by the following procedure. After calibration of the sensor as described above in Section 8.1.1.2, electrical power is applied to the CAL resistor. The calibration factor is given by the formula:

CAL factor = reading on meter / applied electrical power.

If you wish to check and adjust the power reading, apply electrical power to the CAL resistor, and measure the voltage and current to obtain the applied power. The correct power reading for the meter is the applied electrical power multiplied by the CAL factor given above.

8.1.4 Recalibration of Thermopil Heads Using the Nova

If your measuring head is equipped with the exclusive Ophir CAL resistor then calibration is performed according to the instructions in Section 8.1.4.2.

If you do not have the CAL resistor, then you can recalibrate from a known source of power or energy following the instructions in Section 8.1.4.3.

On the rear center of the sensor disc is the exclusive Ophir calibration heater. The disc can be heated by electrical power instead of by radiation by applying electrical power to the terminals at the rear of the sensor head.
By accurately measuring the voltage and current applied, the calibration can be checked and if necessary, readjusted, taking into account the calibration factor. See Section 8.1.3

8.1.4.1 Guidelines for using the CAL resistor for calibration:

1. Do not exceed the maximum electrical power stated in the table.

Model	Power	Aprox. Max Voltage
3A Series	1 Watt	7 Volts
10A Series	10 Watts	17 Volts
30A Series	30 Watts	35 Volts
150A Series	100 Watts	65 Volts
300W Series	125 Watts	65 Volts
1500W Series and above	200 Watts	95 Volts

Table 3.
Maximum Power to Apply to Sensor CAL Resistors

2. Use the resistor for calibration only.
3. Turn off the power as soon as calibration is done.
4. Do not operate the calibration resistor when the sensor disc is under radiation; the excessive heat may burn out the calibration resistor.
5. To eliminate residual non-linear effects, it is advisable to perform electrical calibration at about the same power level as that to be measured, so long as the rating of the heating resistor is not exceeded.

8.1.4.2 Recalibration of Power using the Built in CAL Resistor

If your thermal head has the Ophir CAL resistor then you have a traceable absolute calibration source available just by measuring the voltage and current into the CAL resistor and multiplying by the calibration factor provided by Ophir.

Calibration instructions:

1. Set the instrument to power. If you want to recalibrate energy, this can be done from a known energy source. See section 8.1.4.3.
2. From the bargraph power screen press the right soft key and set to the proper manual power range. Press "exit".
3. Press the menu button twice then "more." Now press select until "calibrate" is highlighted. Press "go".
4. Press "power with CAL" .
5. Using the "laser" button select the proper laser wavelength. (*See note 1 below*). When laser wavelength is set press "go".
6. Using a DC power supply, apply power to the CAL resistor (black and red terminals at the back of the head). For highest accuracy, use the same power as you intend to measure, but do not exceed values in Table 3, Section 8.1.4.1.
7. Maximum voltage applied should not exceed:

$$\sqrt{(\text{resistance of CAL resistor}) \times (\text{maximum power})}$$

8. The voltage should be measured at the input to the head and the current in series with the current loop.
9. Press go and adjust up/down until the power reading on the screen reads the (voltage in volts) x (current in amps) x (current calibration factor for your model and laser or as shown on Nova).

Note 1:

For units which have different calibration factors, e.g. CO2, YAG, or VISIBLE, press "laser" to select correct type of laser before calibration. When recalibrating using the CAL resistor, the other two settings will change proportionately. If you wish to change the calibration of only one laser type, use the function "Power with laser".

Note 2:

The unit retains for your information the current sensitivity of the head in A/W in engineering notation. The original value is retained at the factory. You should record the original setting so you can return to it if you wish.

8.1.4.3 Recalibration from a Known Source of Laser Power / Energy

1. Set the instrument to power or energy depending which you wish to recalibrate.
2. Set to the proper manual power or energy range.
3. From the bargraph power screen press the menu button twice and press "more." ("more" is directly accessible from the energy measurement screen.) Now press select till "calibrate" is highlighted. Press "go".
4. Press "power/energy with laser".
5. Using the "laser" button select the proper laser wavelength. See note 1 below. When laser wavelength is set press "go".
6. Apply the known laser power/energy.
7. Adjust up/down until the power/energy reading on the screen equals the known power/energy. The power/energy calibration factor will change accordingly. See note 1.
8. Press exit. The new value will be saved.

Note 1:

For units which have different calibration factors, e.g. CO2, YAG, or VISIBLE, press "laser" to select correct type of laser before calibration. When recalibrating using "power with laser:" function, only the calibration of the chosen laser wavelength will change. If you wish to change the calibration of all wavelengths proportionately, then use the function "power with CAL".

Note 2:

When changing power calibration, this will also change energy calibration proportionately. However, changing energy calibration will not change power calibration.

8.2 Calibration of Photodiode type Heads

Photodiode detectors are inherently very linear but also have a large variation in sensitivity with wavelength. In addition, the Ophir model PD300 is equipped with both a built in filter and removable filter to allow measurement of higher powers without detector saturation. These filters also have a transmission which depends on wavelength. Therefore, the PD300 Nova has a built in calibration adjustment for wavelength which is described in the next paragraph.

8.2.1 Method of Factory Calibration

The sensitivity of various Ophir photodiode sensors varies from one head to another as well as with wavelength. Therefore, Ophir photodiode detectors are individually calibrated against a NIST standard which has been calibrated at several nm intervals over the entire spectral range.

The spectral sensitivity curve of the detector, both for filter out and filter in, is fed into the head EEROM and this information is used to set the gain to the proper value at all wavelengths.. When the user selects his wavelength on the Nova, the correction factor for that wavelength is applied.
The BC20 head does not have a calibration curve. It is calibrated at the fixed wavelengths that are available with that instrument.

8.2.2 Accuracy of Calibration of PD300 and 3A-IS Heads

Since the instruments are calibrated against NIST standards, the accuracy is generally ±2% at the wavelength the calibration has been performed. The maximum error in measurement will be less than the sum of the calibration accuracy, linearity, inaccuracy due to errors in the wavelength curve and variations in gain with temperature. The linearity of the photodiode detector is extremely high and errors due to this factor can be ignored. The maximum error due to the above factors is given in Table 4 below.

Wave Length	Error, Filter Out*				
	PD300	PD300-3W	PD300-UV	PD300-IR	3A-IS
200 - 250nm			±5%		
250 - 360nm	-	-	±3%		-
360 - 400nm	±10%	±10%	±3%		-
400 - 950nm	±3%	±3%	±3%		5%
950 - 1100nm	±5%	±5%	±5%	±5%	10%
1100 - 1600nm	-	-	-	±5%	
1600-1800nm	-	-	-	±7%	

Table 4 .
Maximum Error as a Function of Wavelength and Filter

* Add ±2% to error for filter in (±3% for PD300-3W and PD300-UV).

8.2.3 Accuracy of calibration of BC20 Heads

The sensitivity of various BC20 sensor varies from one head to another as well as with wavelength. Therefore, each BC20 head is individually calibrated at each specified wavelength against a NIST standard which has been calibrated at the relevant wavelengths.

Since the instruments are calibrated against NIST standards, the accuracy is generally ±2% at the wavelength the calibration has been performed. The maximum error in measurement will be less than the sum of the calibration accuracy and linearity The linearity of the photodiode detector is extremely high and errors due to this factor can be ignored. The maximum error due to all factors is the stated accuracy of ±3%.

The calibration is carried out with a fixed laser. In addition to the error in calibration, the reading drops somewhat with scanning speed. The BC20 is specified to deviate from the static reading no more than –3% up to a scanning velocity of 30,000 inch/sec.

8.2.4 Recalibration of PD300 and 3A-IS Heads from a Known Source of Laser Power

1. Set the instrument to the appropriate manual power range.
2. From the bargraph power screen press the menu button twice and press "more." Now press "select" until "calibrate" is highlighted. Press "go".
3. Using the "laser" button select the proper laser wavelength. See note 1 below. When laser wavelength is set press "go".
4. Apply the known laser energy.
5. Adjust up/down until the power on the screen equals the known power. The power calibration factor will change accordingly.
6. Press exit. The new value will be saved.

Note 1:

The relative readings at different wavelengths are fixed by the wavelength calibration curve stored in the head EEROM. When changing the calibration at one wavelength, the calibration at all other wavelengths will change proportionately.

8.2.5 Recalibration of BC20 heads from a Known Source of Laser Power

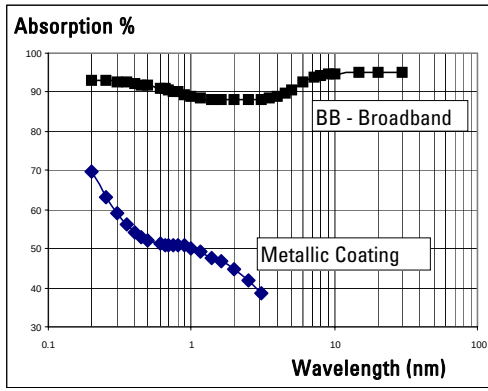
1. Set to the proper manual power or energy range.
2. From the bargraph power screen press the menu button twice and press "more. Now press select till "calibrate" is highlighted. Press "go".
3. Press "power with laser".
4. Using the "laser" button select the proper laser wavelength. Press “go”. Apply the known laser power/energy.
5. Adjust up/down until the power/energy reading on the screen equals the known power/energy. The power/energy calibration factor will change accordingly.
6. Press exit and save.

8.3 Calibration of Pyroelectric and Photodiode Energy Heads

Several types of absorber are used in Ophir pyroelectric and photodiode energy heads:

1. **Metallic type:** The type with no suffix in the name have a partially reflective multilayer metallic coating which absorbs approximately 50% and whose absorption graph is shown in graph 2 below. The metallic coating permits very high repetition rates, up to 5000Hz as well as high sensitivity.
2. **Broadband type:** The type with the BB suffix has a broadband black absorbing coating to provide high absorptivity from the UV through the IR. This coating can withstand energy densities, up to 0.3J/cm² for short pulses and 2J/m² for long pulses without changing calibration. The absorption of this coating is above 90% for most of its range, as shown in Graph 2 below. This coating is available for the PE50 and PE25.

3. **High speed broadband type:** The type with the BBH suffix has a special broadband coating spectrally flat from 190nm to 3µm. Unlike the BB type, it is able to work at high repetition rates to 1000Hz. On the other hand, its damage threshold is considerably lower, on the order of 0.05J/cm².
4. **PD10 type:** Unlike the other heads, the PD10 has a silicon photodiode with a neutral density filter mounted permanently in front of it. The filter detector combination are calibrated over the entire wavelength range similarly to the PD300 power heads and therefore the heads have a high accuracy at any wavelength in the range. This is an exclusive feature with Ophir energy heads.



Graph 2
Absorption of Ophir Pyroelectric Absorbers

8.3.1 Method of Calibration

The sensitivity of the various Ophir pyroelectric sensors can vary from one to another as well as with wavelengths. Therefore, Ophir pyroelectric detectors are individually calibrated against NIST traceable standards. In addition, the calibration is corrected in the Nova for different wavelengths.

Ophir pyroelectric detectors are calibrated using a 1.06µm repetitively pulsed laser referenced to a NIST traceable thermal power meter. The average energy is set to the average power of the standard power meter divided by the laser frequency.

The spectral absorption of the detector coating is measured spectroscopically and the absorption curve is used to correct the calibration for other wavelengths. When the user selects his wavelength on the Nova, the correction factor for that wavelength is applied.

The PD10 heads are calibrated in a two step fashion. First the photodiode detector - filter combination are calibrated against a NIST traceable master in a similar fashion to the PD300 heads over the wavelength range of the head. Then the head is calibrated at one wavelength using a 905nm repetitively pulsed laser referenced to a NIST traceable photodiode meter. The average energy is set to the average power of the standard power meter divided by the laser frequency.

8.3.2 Accuracy of Calibration

Since the instruments are calibrated against NIST standards, the accuracy is generally 3% at the energy level and wavelength at which the calibration has been performed. This accuracy has been verified by checking the scatter of the results when several instruments are calibrated against the same standard. The maximum error in measurement will be less than the sum of the specified accuracy, linearity and inaccuracy due to errors in the wavelength curve.

The non linearity is approximately 2%, and the error due to wavelength is given in table 5 below.

In addition to the above errors, the reading of pyroelectric heads changes with frequency. The Nova has a built in correction for this error. For frequencies above 50% of maximum frequency, inaccuracies in this correction can increase the total error by up to 3%.

The maximum error in measurement will be less than the sum of the above errors and in general will be considerably less.

	Coating Type		
Wavelength	Broadband	Metallic	PD10
	ERROR		
190 - 350nm	±1%	±4%	2%
400 - 800nm	±1%	±4%	0
1064nm	0	0	2%
1-1.5µm	±1%	±2%	N.A.
2 - 3µm	±2%	±8%	N.A.
10.6µm	±5%	±15%	N.A.

Table 5.
Additional Measurement Error due to Wavelength

8.3.3 Recalibration from a Known Source of Laser Energy

1. Set the instrument to energy.
2. Set to the proper energy range.
3. From the bargraph power screen press the menu button twice and press "more." Now press "select" until "cal" is highlighted. Press "go".
4. Using the "value" button, select the time period over which you wish to average. Now press "select" and "value" to choose the correct laser wavelength. See Note 1 below. Now press "go".
5. Apply the known laser energy.
6. Adjust up/down until the energy reading on the screen equals the known energy. The energy calibration factor will change accordingly.
7. Press exit. The new value will be saved.

Note 1:

For metallic and PD10 type heads, when the calibration is changed at one laser wavelength, the overall calibration of all other wavelengths changes proportionately. For BB type, the calibration is only changed for the wavelength set.

8.4 Error Messages

The Nova displays various error messages when operated outside its normal range:

Over-range: When the power or energy being measured exceeds the range of the measurement scale being used, the over-range message is displayed, but the reading still appears on the display. If the power or energy exceeds the maximum by more than 10%, the reading on the display is blanked.

Low Battery: When the battery is almost discharged, the flashing message "BAT" appears. When the low battery message appears, the Nova should be connected to the charger. It will operate normally and charge slowly while connected to the charger. When connected to the charger while turned off, the Nova will charge faster, in about 18 hours.

Sat: When the photodiode current exceeds 1mA and the detector starts to saturate, the message "sat " is displayed.

8.5 Troubleshooting

8.5.1 Nova Display

Problem	Cause/Remedy
Instrument will not operate after being completely discharged and connected to charger.	Check that charger provides 200mA.
Instrument operates with charger but not with battery.	Battery is low. Recharge overnight with the Nova turned off for 14-16 hours. If the Nova still doesn't work with battery, then the NiCd battery is dead. Replace battery.

8.5.2 Thermal Heads, Energy Measurements

Problem	Cause/Remedy
Instrument triggers on background noise or sometimes fails to catch large pulse.	Increase threshold level; See Section. 4.5.3.
Instrument does not show ready for a long while after a reading is made.	Increase threshold level; See Section 4.5.3.
Non-reproducible results when measuring very small energy pulses; or no response to pulses at low energy.	Decrease threshold level: See Section 4.5.3.

8.5.3 Thermal Heads, Power

Problem	Cause/Remedy
Instrument shows zero reading in both power and energy modes.	Check connections between the head and the instrument. See signal tracing (Section 8.6) Check that the sensor disc is operative. Resistance between pins 1 and 9 of the head connector should be about 1.8k. If the sensor is defective, there will be an open or short circuit.
Instrument responds while head is cold, but suddenly fails as it heats up.	Replace sensor disc. See Section-8.6.1.2.
Instrument does not return completely to zero on power measurement.	If head is very hot, allow it to cool. Disconnect the head from the instrument. If readout unit does not zero, adjust zero with head disconnected. If the offset persists, try zeroing with the head connected as well, as described in Section 3.5.2.

8.5.4 Pyroelectric Heads

Problem	Cause/Remedy
1. Instrument reads incorrectly or erratically. Especially on sensitive scale. 2. Instrument triggers even without being exposed to laser pulses. 3. Instrument shows frequency which is too high.	Possible electromagnetic interference from pulsing laser is causing misreading and/or false triggering. Check the following: 1. Head is mounted to stand using insulated plastic rod provided with instrument, and not metal rod. 2. Try keeping cable away from bench. 3. Move head/display further away from EMI.

8.6 Maintenance

8.6.1 Maintenance of Thermal Heads

8.6.1.1 Tracing the Signal from the Head to the Nova

1. With the instrument on, apply an approximately known amount of power to the head. This test can be performed using either a laser or an electrical power supply and the calibration resistor.
2. Estimate the approximate signal current that should be developed by the head by multiplying the input power by the head-sensitivity shown in the head specification table.
3. Unplug the head from the Nova and check that this current appears between pin 1 and 9 of the D type plug.

8.6.1.2 Disc Replacement

If you have ordered a replacement disc, it has been factory calibrated for the wavelength region shown on the calibration sheet sent with the disc.

It has been calibrated at the wavelength requested, or for the 3 wavelengths listed. If it is a CAL type disc, a CAL Factor is also included to use for electrical calibration checks on your power/energy meter. Please follow the following steps in disc replacement.

1. Remove the screws from the front and rear flanges of the absorber head.
2. Remove the front flange and raise the rear flange, taking care not to tear the wires attached to the connectors.
3. Unsolder the wires from the faulty absorber disc attached to the BNC connector in the head, remembering which wire is connected to each terminal.
4. Pry the absorber disc free from its seat by using a screwdriver in the hole provided at the edge of the seat.
5. Smear the absorber disc seat evenly with silicone heat sink compound.
6. Feed the wires through the hole and install the new disc. It is best to turn the disc back and forth a few times while pressing on it, to ensure good contact between the disc, grease and head.
7. Reassemble the front flange, making sure the screws are tight.
8. Resolder the two wires to their proper locations on the rear flange and reassemble the rear flange.

8.6.1.3 Recalibrating the Head to a new Disc

1. From the bargraph power measurement screen press the menu button twice, then press "more".
2. Press "select" until "calibrate" is highlighted. Press "go" then "power with CAL". Press "laser" and select the first laser wavelength sent with the disc. Now press "go" and adjust up/down until the sensitivity agrees with that sent with the disc. Now press exit to save the new value.
3. For heads with calibration at several laser wavelengths, you now have to adjust the calibration for the other wavelengths.

From the bargraph power measurement screen, press the menu button twice and press "more". Press "select" until "calibrate" is highlighted. Press "go". Now press "power with laser". Use the "laser" button to select one of the laser wavelengths. Press "go" and adjust until the cal factor is the same as that sent with the disc for the wavelength shown. Now press "exit" to save that value.

4. Now repeat step 3 for the other laser wavelengths. Each time, use the "laser" button to select a different laser wavelength and enter the proper calibration factor sent with the disc for that wavelength.

8.6.2 Replacing Battery

1. Remove the bottom of the Nova by unscrewing the 4 Phillips screws.
2. Unscrew screw in the center of the PC boards. Carefully lift the boards up together.
3. Unplug the battery connector from the circuit board.
4. Remove the battery and replace it with a new one obtained from your Ophir representative.
5. Reassemble the boards and screw in the center screw. Now reassemble into the case and close 4 case screws.

Chapter 9 Nova Specifications

9.1 System/Display Specifications

Detector Compatibility	Thermopile, photodiode pyroelectric, OEM
Input ranges	15nA - 1.5mA full scale in 16 ranges
A to D Sampling rate	15Hz
A to D resolution	17 bits plus sign. (0.0007% resolution)
Electrical accuracy	±0.25% ± 20pA new; ±0.5% ±50pA after 1 year
Electrical input noise level	500nV or 1.5pA + 0.0015% of input range @3Hz.
Dynamic range	9 decades (1:10^9)
Analog output	0-1 Volt with 11-bit (0.05% resolution.)
Analog output accuracy	±0.2% ±2mV relative to display
Dimensions	203H x 95W x 37D (mm)
Mass	550g
Display	122 x 32 pixel Super twist LCD
Display digit height	12mm
Backlight	EL: Operates from charger power only
Bargraph segments	120
Battery	2 X RR (Sub-C) 1.8Ah NiCd. Built in.
Operation between charges	18 Hrs, 10Hrs with pyroelectric heads. Battery charge time10-14 Hrs (15-30 Hrs if operating)
Charger	DC: 11 to 22V: or AC 9 to 15Vrms 3 Watt.

9.2 Head Specifications

HEAD	MAX POWER (WATTS)	MAX AVG. POWER DENSITY	ABSORBER TYPE
PD300/UV/IR	300mW	50W/cm²	PD
PD300-3W	3W	50W/cm²	PD
3A-IS	3W	200W/cm²	Int Sph PD
F100A-IS	100W	200W/cm²	Int Sph Ther
2A	2W	200W/cm²	BB
3A-P-CAL	3W	50W/cm²	P
10A-P	10W	50W/cm²	P
30A-P	30W	50W/cm²	P
30(150)A-HE	30(150)W	1000W/cm²	HE/HE1
10A	10W	20KW/cm²	BB
30A	30W	20KW/cm²	BB
30(150)A	30(100)W	20KW/cm²	BB
F150A	150W	20KW/cm²	BB
FL250A	250W	20KW/cm²	BB
F300A	300W	20KW/cm²	BB/LP
1000W	1000W	6KW/cm²	BB
1500W	1500W	6KW/cm²	BB/LP
5000W	5000W	5KW/cm²	BB/LP
8000W	8000W	5KW/cm²	BB/LP
L30A-EX	30W	1KW/cm²	EX
FL250A-EX	250W	1KW/cm²	EX
PD10	20mW	50W/cm²	PD
PE10	2W	50W/cm²	PE
PE25	10W	10W/cm²	PE
PE50	20W	10W/cm²	PE
PE50-DIF	40W	500W/cm²	PE

Table 6.
Max Power Specifications of Heads

PD - Photodiode
P - P type volume absorber for short pulse lasers
HE/HE1- volume absorber for high energy pulses
EX - Excimer type, volume absorber
PE - pyroelectric metallic or black absorber
BB - broadband surface absorber, high power density
LP - broadband surface absorber for highest power density

Absorber Type	Max Energy Density J/cm² Pulse Length		
	10ns	1µs	300µs
P	10	10	10
HE/HE1	5	10	100
BB	0.3	0.5	5
EX	0.5	0.6	4
PE, Metallic	0.1	0.2	4
PE, BB	0.3	0.3	1
PE-DIF	1.5	3	40
PE BB-DIF	3	3	10

Table 7.
Maximum Energy Densities for Various Absorbers